FINAL SUBMITTAL

VOLUME II

APPENDICES

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS FT. SILL, OKLAHOMA

Prepared for

TULSA DISTRICT
CORPS OF ENGINEERS
TULSA, OKLAHOMA

Under

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ac	-	alternating current
ACCU	-	air cooled condensing unit
AEL	-	acceptable exposure limit
AHU	-	air handling unit(s)
amp	-	ampere (amp, amps)
ANSI	-	American National Standards Institute
ASCII	-	American Standard Code for Information Interchange
ASHRAE	-	American Society of Heating, Refrigeration, and Air Conditioning Engineers
AWG	-	American wire gauge
bar	-	bar: 14.5 psi
BAU	-	business as usual
B/C	-	benefit-to-cost ratio
Bhp	-	brake horsepower
Bks	-	barracks
BLAST	-	Building Loads Analysis and System Thermodynamics Program, CERL
Bldg	-	building
BOQ	-	Bachelor Officer's Quarters
Btu	-	British thermal units
Btuh	-	British thermal units per hour
B/W	-	black and white
°C	-	Celsius (Centigrade)(degrees)
cc	-	cubic centimeter

ccf	-	one hundred (100) cubic feet
CEP	-	central energy plant
CFC	-	chlorofluorocarbons
cfh	-	cubic feet per hour
cfm	-	cubic feet per minute
ckVAR	-	capacitive kilovolt-ampere reactive
CNW	-	condensed water
CNWP	-	condensed water pump
CNWR	-	condensed water return
CNWS	-	condensed water supply
CO	-	carbon monoxide
COND.	-	condenser
const	-	construction
COP	-	coefficient of performance: ratio of the tons of refrigeration produced to the energy required to operate the equipment
CO_2	-	carbon dioxide
CPU	-	central processing unit
CY	-	current transducer
CTD	-	Carnahan-Thompson-Delano
CTM	-	cooling tower motor
cu ft	-	cubic foot, cubic feet
CW	-	chilled water

CWE	-	current working estimate
CWP	-	chilled water pump
CWR	-	chilled water return
CWS	-	chilled water supply
CV	-	converter
d	-	day(s)
DB	-	dry bulb
DD	-	Degree Day: the difference between the median temperature for any hour and a selected base temperature (generally 65°F)
deg	-	degrees
DEH	-	Director of Engineering and Housing
DHW	-	domestic hot water
Di	-	inside diameter
DOM.	-	domestic
DP	-	differential pressure transducer
DX	-	direct expansion
E_b	-	boiler efficiency
E/C	-	energy-to-cost ratio
ECIP	-	Energy Conservation Investment Program
ECO	-	energy conservation opportunity(s)
EEAP	-	Energy Engineering Analysis Program
eff	-	efficiency

EIC	-	Engineer In Charge
elec	-	electrical
E_m	-	motor efficiency
EMC	-	E M C Engineers, Inc.
EMCS	-	Energy Monitoring and Control System
EPA	-	Environmental Protection Agency
eqpt	-	equipment
F	-	flow meter
°F	-	Fahrenheit (degrees)
FLA	-	full load amps
ft	-	foot, feet
ft^2	-	square feet
ft^3	-	cubic feet
FO	-	fuel oil
gal	-	gallon(s)
g/dscm	-	grams per dry standard cubic meter
gpm	-	gallons per minute
HCFC	-	hydrochlorofluorocarbon
HCP	-	hot/chilled water pump
HCR	-	hot/chilled water return
HCS	-	hot/chilled water supply
HCW	-	hot/chilled water

HG	-	mercury
hp	-	horsepower
hr	-	hour(s)
HTHW	-	high temperature hot water
H&V	-	heating and ventilating
HVAC	-	heating, ventilating, and air conditioning
HW	-	hot water
HWR	-	hot water return
HWS	-	hot water supply
Hz	-	hertz, frequency
in	-	inch(es)
I/O	-	input/output
°K	-	kelvin (degrees)
kip	-	one thousand pounds
kW	-	kilowatt, one thousand watts
kWh	-	kilowatt-hour, one thousand watthours
kV	-	kilovolt, one thousand volts
kVAh	-	kilovolt-ampere hour, one thousand volt-ampere hour(s)
kVAR	-	kilovolt-ampere reactive
kVARh	-	kilovolt-ampere reactive hour, one thousand volt-ampere reactive hour(s)
L	-	length

lb	-	pound(s)
LCC	-	life cycle cost
LCCID	-	life cycle cost in design
LTHW	-	low temperature hot water
m	-	meter
m^3	-	cubic meters
maint	-	maintenance
Mbh	-	Btu per hour (thousand)
mcf	-	one thousand cubic feet
MCP	-	Military Construction Program
Mh	-	man-hour(s)
mm	-	millimeter
MMBtu	-	British thermal units (million)
MMBtuh	-	Btus per hour (million)
mo.	-	month(s)
MUX	-	multiplexer
mW	-	megawatt, one million watts
mWh	-	megawatt-hour, one million watt-hours
MZU	-	multizone unit
N/A	-	not available or not applicable
nat	-	natural (gas)
NBS	-	National Bureau of Standards

NOAA	-	National Oceanic and Atmospheric Administration
no.	-	number
O_2	-	oxygen
OA	-	outside air
O & M	-	operation and maintenance
PD	-	pressure drop or difference
PLT	-	plant
PF	-	power factor: relationship between kW and kVA. When the power factor is unity, kVA equals kW.
PM	-	Project Manager
ppm	-	parts per million
psi(a)(g)	-	pounds per square inch (absolute)(gauge)
Q	-	flow rate
R	-	return
RDF	-	refuse derived fuel
RET.	-	return
RVAC	-	refrigeration, ventilation, air conditioning
R-value	-	the resistance to heat flow expressed in units of (ft^2) x (hours) x (°F)/Btu; R-value = 1/U-value
S	-	supply
scf	-	standard cubic feet
scfm	-	standard cubit feet per minute

SIR	-	Savings-to-Investment Ratio: total life cycle benefits divided by 90% of the differential investment cost
SIOH or SIA	-	supervision, inspection, and overhead
SOW	-	scope of work
sq ft	-	square foot (feet)
st/sp	-	start/stop
SWPA	-	Southwestern Power Administration
SZU	-	single zone unit
stby	-	standby
t	-	ton, a means of expressing cooling capacity: 1 ton - 12,000 Btu/hr cooling
T	-	temperature
temp	-	temperature
TD	-	temperature difference
T_f	-	fluid temperature (°C)
T_g	-	ground temperature (°C)
TPF	-	third party financing
TRY	-	Test Reference Year
UA	-	overall heat transfer coefficient (Btu/hr-°F)
UPW	-	uniform present worth factor: a factor which, when applied to annual savings, will account for the time value of money and inflation over the life of the project
U.S.	-	United States

U-value	-	a coefficient expressing the thermal conductance of a composite structure in Btu per (sq ft)(hour)(°F temperature difference); Btu/ft^2 x hr x °F); U-value = 1/R-value
V	-	volt(s)
VAT	-	value added tax
VAV	-	variable air volume
VSD	-	variable speed drive
W	-	watt(s)
WB	-	wet-bulb
wk	-	week(s)
yr	-	year(s)

APPENDIX A

SCOPE OF WORK

SCOPE OF WORK SUMMARY
ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS, Fort SILL, OKLAHOMA

ITEM NO.	SOW PAGE	SOW SECTION	DESCRIPTION	REPORT SECTION
1	1	1.1	Survey the boilers to determine their efficiency.	2.0
2	1	1.3	Identify and list all ECOs considered.	4.0
3	1	1.3	Identify low cost or no cost ECOs.	6.0
4	1	1.6	Prepare report.	-
5	1	2.1	Include in the study the results of previous studies concerning boiler and chiller plants.	5.0
6	2	2.5	Determine if ECOs are technically and economically feasible.	4.0
7	2	2.5	Combine ECOs into larger packages for ECIP or MCP funding.	8.0
8	2	2.6	List and prioritize, by SIR, projects which qualify for ECIP funding.	Table 7-2
9	2	2.7	Prioritize, by SIR, feasible non-ECIP projects.	8.0
10	4	5.1	Develop life cycle cost analysis summary sheets for ECIP projects.	Appendix D
11	4	5.1	Provide original backup calculations from previous studies.	Appendix G and H
12	5	5.2	Develop life cycle cost analysis summary sheets for non-ECIP projects.	Appendix D
13	6	5.3	Document nonfeasible ECOs in the report.	4.0
14	6	7.1.1	Conduct boiler efficiency tests.	Appendix F, Survey Notes
15	6	7.1.2	Conduct chiller efficiency tests.	Appendix E, Survey Notes
16	7	7.2.2	Investigate existing local controls and incorporate into EMCS.	4.0
17	7	7.2.3	Review, document, and evaluate operation and maintenance practices.	2.0 and 6.0

SCOPE OF WORK SUMMARY (Concluded)
ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS, Fort SILL, OKLAHOMA

ITEM NO.	SOW PAGE	SOW SECTION	DESCRIPTION	REPORT SECTION
18	7	7.3	Thoroughly evaluate and document all potential ECOs which are not eliminated.	Appendix D
19	8	7.6	Prepare a comprehensive report.	Interim Submittal
20	10	7.6.1	Interim submittal - include analyses performed to date and results of field survey.	Interim Submittal
21	10	7.6.1	Interim submittal - include copies of the Scope of Work and any modifications.	Appendix A
22	10	7.6.1	Interim submittal - provide a narrative summary.	Executive Summary
23	10	7.6.1	Interim submittal - include copies of field survey forms.	Appendix E and F
24	10	7.6.2	Prefinal submittal - document the integrated aspects of the study.	8.0
25	10	7.6.2	Prefinal submittal - include an order of priority, by SIR, for the recommended ECOs.	8.0
26	11	7.6.2	Prefinal submittal - include an executive summary per Annex D.	Executive Summary
27	11	7.6.2	Prefinal submittal - list all projects and ECOs developed in the study.	7.0 and 8.0
28	11	7.6.3	Final Report - incorporate revisions and corrections resulting from comments.	Final Report
29	11	8.2	Identify operational items noted in the study which will effect energy conservation.	Section 6.0
30	6	7.1.1 & 7.1.2	Use metering equipment with the proper accuracies and calibration.	Appendix E
31	A-17	-	Present overview of the impact on changing refrigerants to environmentally safe refrigerants.	Section 5.0
32	-	-	Plants included in study: 730, 914, 2812, 4701, 5676, 5678, 5900, 6003.	-

SCOPE OF WORK SUMMARY, ECOs EVALUATED
ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS, Fort SILL, OKLAHOMA

ECO DESCRIPTION IN SOW	SOW LOCATION	ECO NO.	ECO DESCRIPTION IN REPORT
Controls to assure proper combustion air-fuel ratio.	Annex A	10	Installation of combustion controls.
Installation of new burner equipment.	Annex A	11	Installation of new high efficiency burner.
Economizer or air preheater.	Annex A	12	Installation of stack economizer or air preheater.
Loading characteristics and scheduling versus equipment capacity (equipment optimization).	Annex A	2 & 8	2 - Chiller optimization. 8 - Boiler optimization.
Control systems to operate chillers at the most energy efficient operating condition.	Annex A	2	Chiller optimization.
Variable or two-speed cooling tower fan.	Annex A	5(A) & 5(B)	5(A) Two-speed motors. 5(B) Variable speed control.
Storage of chilled water or other thermal storage systems.	Annex A & Conf. Notice 1	4	Ice storage cooling system.
High efficiency motors.	Annex A	6	High efficiency motors.
Instruments and controls to facilitate efficient operations.	Annex A	1 & 7	1 - Chiller instruments. 7 - Boiler instruments.
Use smaller boilers where load has been reduced.	Annex A	8	Boiler optimization.
Replace inefficient boilers with more efficient boilers (or repair).	Annex A (para 7.2.1)	9	Renovate or replace boilers.
Replace inefficient chillers with more efficient chillers (or repair).	Annex A (para 7.2.1)	3	Renovate or replace chillers.

Appendix A

GENERAL SCOPE OF WORK

FOR AN

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS

FOR

FORT SILL, OKLAHOMA

Performed as part of the

ENERGY ENGINEERING ANALYSIS PROGRAM

Exhibit 1

1. <u>BRIEF DESCRIPTION OF WORK</u>: The Architect-Engineer (AE) shall:

1.1 Determine the efficiency of the boiler/chiller plants by appropriate tests.

1.2 Survey the boiler/chiller plants to determine if efficiency can be improved by the repair, addition, or modification of equipment, control systems and operation and maintenance practices and recommend improvements.

1.3 Identify all energy conservation opportunities (ECOs) including low cost/no cost items and perform complete evaluations of each.

1.4 (Deleted)

1.5 (Deleted)

1.6 Prepare a comprehensive report to document the work performed, the results and recommendations.

2. <u>GENERAL</u>

2.1 Other studies performed under the Energy Engineering Analysis Program (EEAP) have been performed at the installation and may have included the boiler/chiller plants. Results of the previous studies concerning the boiler/chiller plants shall be included in this study. Boiler/chiller plant projects recommended in the previous studies shall be updated and included in this report if they have not been implemented or programmed. Any reports or studies that may have been accomplished on the boiler/chiller plants shall be reviewed by the AE and information included in this report as applicable.

2.2 The information and analysis outlined herein are considered to be minimum essentials for adequate performance of this study.

2.3 This study shall include the boiler plant, chiller plant, all appurtenances, and supporting systems (e.g., fuel storage facilities, pollution abatement, water treatment, etc.). It does not include steam or chilled water distribution systems. However, if during the survey readily identifiable energy conservation opportunities pertaining to the distribution systems are noted, they shall be listed in the report.

2.4 The "Energy Conservation Investment Program (ECIP) Guidance," described in letter from CEHSC-FU, dated 25 April 1988, and revised in letter from CEHSC-FU-P, dated 15 June 1989, establishes criteria for ECIP projects and shall be used for performing the economic analysis of all projects or improvements considered.

2.5 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP or MCA funding, and determining, in coordination with installation personnel, the appropriate packaging and implementation approach for all feasible ECOs. Energy conservation opportunities which do not fit into projects, such as operation procedure changes, shall be developed into detailed and specific instructions and procedures for operating personnel.

2.6 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.7 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

2.8 Energy Conservation and Management (ECAM) projects for procurement-funded installations will be identified and analyzed using the same criteria as for ECIP. ECAM and ECIP will be considered synonymous in this Scope of Work.

3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for all work required under this contract. Upon the award of the contract, this individual shall be immediately designated in writing. The AE's designated project manager must be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for complete coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.

3.2 Installation Assistance. A coordinator designated by the Commanding Officer at each installation will serve as the point of contact for obtaining available information and assist-

ing in establishing contacts with the proper individuals and organizations as necessary to accomplish the work required under this contract.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed under this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE and/or the designated representative(s) shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The AE, consultants, if applicable, and/or designated representative(s) thereof shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number, if applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, supplies, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of work under this contract. The record shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The AE and the Government's representative shall conduct entry an exit interviews with the Director of Engineering and Housing before starting work at the facility and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1 Entry. The entry interview shall thoroughly brief and describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

a. Schedules.

b. Names of energy analysts who will be conducting the survey.

c. Proposed working hours.

d. Support requirements from the Director of Engineering and Housing.

3.7.2 Exit. The exit interview shall include a thorough briefing describing the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Engineering and Housing.

4. SERVICES AND MATERIALS. All services, supplies, materials (except those specifically enumerated to be furnished by the Government), plant, labor, testing equipment, superintendence and travel necessary to perform the work and render the data required under this contract shall be included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION. All energy conservation opportunities which the AE has considered shall be included in one of the following categories and presented as such in the report:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $200,000, a Savings to Investment Ratio greater than one and a simple payback period of less than eight years. For ECAM projects the $200,000 limitation may not apply. The AE shall check with the installation for guidance. The overall project and each discrete part of the project shall have a SIR greater than one.

A Life Cycle Cost Analysis Summary Sheet shall be developed for each ECO and for the overall project when more than one ECO is combined. For projects and ECOs updated or developed from the previous studies, the backup data shall consist of copies of the original calculations and analysis, with new pages revising the original calculations and analysis. In addition, the backup data shall include as much of the following as is available: the increment of work the project or ECO was

developed unuer in the previous study, title(s) of the project(s), the energy to cost (E/C) ratio, the benefit to cost (B/C) ratio, the current working estimate (CWE), and the payback period. This information shall be included as part of the backup data. The purpose of this information is to provide a means to prevent duplication of projects in any future reports.

5.2 Non-ECIP Projects. Projects which normally do not meet ECIP criteria, but which have an overall SIR greater than one shall be individually packaged and fully documented. The Life Cycle Cost Analysis Summary Sheet shall be completed through and including line 6 for all projects or ECOs. Each shall be analyzed to determine if they are feasible even if they do not meet ECIP criteria. These ECOs or projects may not meet the nonenergy qualification test. For projects or ECOs which meet this criteria, the Life Cycle Cost Analysis Summary Sheet, completely filled out, with all the necessary backup data to verify the numbers presented, a complete description of the project and the simple payback period shall be included in the report.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with the reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK: The general Scope of Work is intended to apply to contract efforts for all Army boiler and chiller plants except as modified by the detailed Scope of Work for each specific installation. The detailed Scope of Work is contained in Annex B.

7. WORK TO BE ACCOMPLISHED

7.1 Determine Efficiency

7.1.1 Boilers. The efficiency of the existing boiler installation shall be determined by field testing. The AE shall provide equipment and perform tests in the field to establish the efficiency of the boilers. The tests are intended to determine the efficiency of the boilers as they are actually being operated. The AE shall document any changes made to controls or equipment during boiler efficiency tests.

The AE shall submit the proposed test procedure and testing laboratory to the Contracting Officer for approval. Based upon the results of the tests, any indicated areas of improvement or equipment modification shall be fully analyzed. The study shall establish equipment operating data baselines, system efficiency modeling, and evaluate plant and unit loading profiles versus equipment capacities. The Government will furnish fuel, utilities, other consumables, and provide personnel to operate the plant during testing. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.1.2 Chillers. The efficiency of the existing chiller plant shall be analyzed and evaluated to determine if system efficiency can be improved or energy saving improvements implemented. The efficiency of the existing chillers shall be calculated using standard methods. Meters shall be used to obtain the necessary data to calculate efficiency. The AE is responsible for any metering necessary. If meters are existing, they may be used if their validated accuracy is within the limits specified below. If no meters are present, the AE is responsible for installing temporary meters. Permanent taps or connectors shall be installed so as to cause minimal disruptions to the system. Ultrasonic metering may be used. All meters used must have an accuracy of ± 2 percent and a statement to that effect, signed by an independent testing laboratory must be included in the report. Efficiency tests shall be made at normal operating parameters.

7.2 Survey Existing Plants

7.2.1 The condition of the existing plant shall be studied, documented, and evaluated. possibilities of repairing or replacing equipment or revising systems which will result in improved efficiency or reduced cost of operation shall be investigated.

7.2.2 The existing control system will be investigated, evaluated and documented to determine if equipment can be improved through upgrading, adjustment, repair or replacement, and if an alternate control system would increase efficiency. If an alternate system is recommended, interim improvements to existing controls shall also be recommended, if applicable. Engineering and economic analysis shall be developed. New controls proposed shall be Energy Monitoring and Control Systems (EMCS) compatible. Corps of Engineers Guide Specification (CEGS) 13946, Building Preparation for EMCS, shall be used as a standard for an interface to the existing plant. If an EMCS exists, interaction between this system and proposed modifications shall be clearly defined. The AE shall notify the DEH at least ten days prior to any pending outages of equipment and obtain concurrence prior to proceeding with any work.

7.2.3 The present boiler and chiller operation and maintenance practices shall be reviewed, documented, and evaluated with the intent to increase efficiency. The alternatives and recommendations shall be developed, evaluated, and documented in the report. Recommendations shall be in sufficient detail so that they can be quickly implemented. Detailed engineering and economic analysis of these actions are not required, however, a description and evaluation of these recommendations will be included in the report.

7.3 Identify ECOs. All methods of energy conservation which are reasonable and practical shall be considered, including operational methods and procedures and maintenance practices as well as physical facilities. A list of energy conservation opportunities is included as Annex A to this scope. This list is not intended to be restrictive but only to assure that at least these opportunities are considered, discussed and documented in the report. Each of the items shall considered and discussed in the report. Those items on the list which are not practical, have been previously accomplished, are inappropriate or can be eliminated from detailed analysis based on preliminary analysis shall be listed in the report along with the reason for elimination from further analysis. All potential ECOs which are not eliminated by preliminary considerations shall be thoroughly documented and evaluated as to the technical and economic feasibility. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an or-

derly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A Life Cycle Cost Analysis Summary Sheet shall be prepared for each ECO and included as part of the supporting data.

7.4 (Deleted)

7.5 (Deleted)

7.6 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. The AE shall give a formal presentation of all but the final submittal to installation, command, and other Government personnel. The AE shall prepare slides or view grapns showing the results of the study to date for his presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. The AE shall provide the comments from all reviewers and written

notification of the action taken on each comment to all reviewing agencies within three weeks after the review meeting. It is anticipated that each presentation and review conference will require approximately one working day. The presentation and review conferences will be at the installation on the date(s) agreeable to the Director of Engineering and Housing, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.6.1 Interim Submittal. An interim report shall be submitted for review after completion of the field survey and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings and SIRs of all the ECOs shall be included. The simple payback period of all ECOs shall be calculated and shown in the report. The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. During the review period, the Government's representative shall coordinate with the Director of Engineering and Housing and provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared.

The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.6.2 Prefinal Submittal. The AE shall prepare and submit the prefinal report when all work under this contract is complete. The AE shall submit the Scope of Work for the installation studied and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The report shall include an order of priority by SIR in which the recommended ECOs should be accomplished. The synergistic effects of all of the ECOs on one another shall have been determined and the results of the original calculations adjusted accordingly.

The prefinal report, separately bound Executive Summary and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The prefinal submittal shall be arranged to include (a) a separately bound Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex D for minimum requirements), (b) the narrative report containing a copy of the Executive Summary at the beginning of the volume and describing in detail what was accomplished and the results of this study, (c) appendices to include the detailed calculations and all backup material.

A list of all projects and ECOs developed during this study shall be included in the Executive Summary and shall include the following data from the Life Cycle Cost Analysis Summary Sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.

7.6.3 Final Submittal. Any revisions or corrections resulting from comments made during the review of the prefinal report or during the presentation and review conference shall be incorporated into the final report. These revisions or corrections may be in the form of replacement pages, which may be inserted in the prefinal report, or complete new volumes. Pen and ink changes or errata sheets will not be acceptable. If replacement pages are to be issued, it shall be clearly stated with the prefinal submittal that the submitted documents will be changed only to comply with the comments made during the prefinal conference and that the volumes issued at the time of the prefinal submittal should be retained. Failure to do so will require resubmission of complete volumes. If new volumes are submitted, they shall be in standard three-ring binders and shall contain all the information presented in the prefinal report with any necessary changes made. Detailed instructions of what to do with the replacement pages should be securely attached to the replacement pages.

8. <u>OPERATION AND MAINTENANCE</u>. The contractor will identify operational items noted during the study, which will effect energy conservation, and will explain the savings possible.

ANNEX A

GENERAL ENERGY CONSERVATION OPPORTUNITIES AND OTHER CONSIDERATIONS

General Energy Conservation Opportunities:

- o Controls to assure proper combustion air-fuel ratio.
- o Installation of new burner equipment.
- o Economizers/air preheaters.
- o Loading characteristics and scheduling versus equipment capacity (equipment optimization).
- o Control systems to operate chillers at their most energy efficient operating condition.
- o Variable or two-speed cooling tower fan.
- o Storage of chilled water.
- o High efficiency motors.
- o Instruments and controls to facilitate efficient operations.
- o Use smaller boilers where load has been reduced.
- o Replace inefficient boilers with more efficient boilers.
- o Replace inefficient chillers with more efficient chillers.

o Generate electricity on-site with natural gas turbine engines and reclaim heat from those engines to produce steam for steam turbine chillers or domestic hot water/steam.

o Use natural gas engine driven chillers and reclaim heat from engines and condensers to produce domestic hot water.

Other Considerations (General Overview Only):

o Provide the general impact on efficiency and capacity of changing the refrigerant to an environmentally safe refrigerant.

o Generally, determine the extent of equipment modifications ("O" rings, gaskets, motor stators, controls, etc.) required for a new refrigerant.

o Generally, determine special life safety features required when new refrigerants are used (sensors, alarms, ventilation, etc.).

ANNEX B

DETAILED SCOPE OF WORK

1. General. This Detailed Scope of Work supplements the General Scope of Work and provides information and requirements specific to the Energy Survey of Army Boiler and Chiller Plants at Fort Sill. Any conflicts in requirements between the General and Detailed Scopes of Work will be resolved by the Corps of Engineers Project Manager.

2. Boiler/Chiller Plants to be Surveyed. Attachment 1 (Boiler/Chiller Plant List) to this Annex B lists the boiler/chiller plants (in priority order) to be surveyed under this contract. The Architect-Engineer (AE) will verify the pertinent data in Attachment 1 and develop a testing plan for each boiler/chiller. Those plans will outline the details of any modifications/attachments to plant equipment required in the tests and the plans will be provided to Fort Sill DEH for review and approval. The AE will comply with Occupational Safety and Health Administration (OSHA) Asbestos Standards 1910.1001 and 1926.58 and 40 CFR 61(m) in conducting any work involving asbestos. The AE will also address the Special Considerations outlined in Attachment 1 and present the findings in the report.

3. Previous Boiler/Chiller Plant Studies. As outlined in the General Scope of Work, the AE shall update boiler/chiller projects recommended in previous studies if they have not been implemented or programmed. The statuses of those previously recommended projects are as follows:

a. Central Energy Plant Nos. 445, 462, 730, 913, 1603, and 1653 to be replaced by single 800 Area central energy plant -- neither implemented nor programmed.

b. Chilled Water Plant No. 2471 (serving barracks Nos. 2470 and 2471) to be replaced with extension of chilled water piping from Plant No. 3442 -- designed, but not funded.

c. Central Energy Plant Nos. 5900 and 6003 to be expanded to serve future facilities -- Plant No. 5900 expansion has been completed; however, further expansion using waste oil/sludge fired boilers has been considered -- Plant No. 6003 expansion has neither been implemented nor programmed.

4. Government Furnished Information. The following information will be furnished as required and upon request of the AE:

a. Previously completed studies performed under the Energy Engineering Analysis Program (EEAP) and other programs. The AE may review study availability at Fort Sill DEH Energy Office.

b. Fort Sill Energy Resources Management Plan.

c. ETL 1110-3-282, Energy Conservation.

d. ETL 1110-3-301, Entrance Doors to Heater/Boiler Rooms.

e. ETL 1110-3-318, Procedures for Programming Energy Monitoring and Control Systems (EMCS) Funded Through the MCA Program.

f. ETL 1110-3-332, Economic Studies.

g. ETL 1110-3-354, Direct Digital Control of Heating, Ventilation and Air Conditioning (HVAC) Systems.

h. Office, Chief of Engineers Architectural and Engineering Instructions, July 1989.

i. Energy Conservation Investment Program (ECIP) Guidance, dated 25 April 1988 and revision dated 15 June 1989.

j. Information on Existing EMCS Studies, Designs, Construction Contracts, or Operating Systems.

k. TM 5-785, Engineering Weather Data.

l. TM 5-800-2, General Criteria Preparation of Cost Estimates.

m. TM 5-800-3, Project Development Brochure.

n. TM 5-815-2, Energy Monitoring and Control Systems (EMCS).

o. AR 415-15, Military Construction Army (MCA) Program Development.

p. AR 415-17, Cost Estimating for Military Programming.

q. AR 415-20, Construction, Project Development and Design Approval.

r. AR 415-28, Department of the Army Facility Classes and Construction Categories.

s. AR 415-35, Construction, Minor Construction.

t. AR 420-10, General Provisions, Organization, Functions, and Personnel.

u. AR 11-27, Army Energy Program.

v. AR 5-4, Change No. 1, Depart of the Army Productivity Improvement Program.

w. HNDSP-84-076-ED-ME, Preliminary Survey and Feasibility Study for Energy Monitoring and Control Systems.

x. NCEL CR 82.030, Standardized EMCS Energy Savings Calculations.

y. HNDSP88-207-ED-ME, HNDSP88-208-ED-ME, HNDSP88-209-ED-ME, and HNDSP88-210-ED-ME, EMCS Cost Estimating Guides.

z. Latest applicable Engineering Improvement Recommendation System (EIRS) Bulletin.

aa. Example of a correctly completed implementation document for a project.

bb. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee to AE. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977.

5. Submittals. The AE will make Interim, Prefinal, and Final submittals of the work under this contract as outlined in the General Scope of Work. Attachment 2 (Submittal List) to this Annex B lists the receiving offices, addresses, and number of copies for each submittal. The AE will make submittals directly to the offices listed with a copy of the transmittal letter to the Tulsa District Project Manager.

6. Delivery Schedule. The schedule for completing work under this contract is somewhat dependent on when the peak cooling and peak heating periods occur at Fort Sill. The following target milestones are based on boiler tests being completed by 1 March 1991. Chiller tests will be conducted during the summer of 1990.

Item	Date
Award AE Contract	24 Aug 1990
Interim Submittal	1 May 1991
Interim Submittal Comments	31 May 1991
Prefinal Submittal	1 Aug 1991
Prefinal Submittal Comments	30 Aug 1991
Final Submittal	30 Sep 1991

7. Project Managers/Coordinators. The following persons will serve as points of contact and liaison for all work required under this contract:

AE: (As designated at time of contract award)

Tulsa District: Merle London
US Army Engineer District, Tulsa
ATTN: CESWT-EC-PF
PO Box 61
Tulsa, OK 74121-0061
Tele. No. (918) 581-7991
FAX (918) 581-7365

Fort Sill: Gary Basham
US Army Field Artillery Center and Fort Sill
ATTN: ATZR-EE
Fort Sill, OK 73503-7200
Tele. No. (405) 351-3517
FAX (405) 351-6923

ANNEX B - ATTACHMENT 1

BOILER/CHILLER PLANT LIST

Item	Plant	No. Chillers*	Tons	No. Boilers*	MBTU
Base	5900	5 (F)	2000	6 (F)	65.20
Base	6003	3 (F)	1300	3 (F)	16.20
Base	730	3 (F)	1440	4 (F)	15.99
Opt 1	2812	1 (F)	372	3 (F)	6.03
Opt 2	4701	2 (F)	610+	3 (F)	-
Opt 3	5676	1 (P)	375	2 (P)	2.98
Opt 4	5678	1 (P)	190	2 (P)	3.95
Opt 5	3442	2 (P)	1200	No Boilers	-
Opt 6	914	1 (P)	400	4 (P)	-
Opt 7	1603	1 (P)	345	4 (M)	-
Opt 8	3040	1 (P)	350	2 (P)	-
Opt 9	500	1 (P)	110	1 (P)	-
Opt 10	1490	1 (P)	150	2 (P)	-

NOTE: Above data were extracted from existing records and contain errors/omissions. A-E and Government will jointly verify the data prior to contract negotiations.

* (F) = Full Test, as detailed in Pre-Negotiation minutes.
(P) = Partial Test, as detailed in Pre-Negotiation minutes.
(M) = Minimum Test, as detailed in Pre-Negotiation minutes.

Special Considerations.

Plant No. 730: Determine if capacity of plant is sufficient to serve additional buildings.

Plants Nos. 5676 and 5678: Determine the feasibility of interconnecting these two plants.

Plant No. 3442: Explore opportunity for central heating plant. This proposition was investigated in previous studies.

Plant No. 914: Determine feasibility of using one boiler to serve four buildings (similar to single chiller in plant).

Plant No. 4701: Plant was designed for hospital use, but is to be now used for other purposes. Consider downgrading system to low pressure steam and use excess capacity elsewhere.

ANNEX B - ATTACHMENT 2

SUBMITTAL LIST
FORT SILL BOILER/CHILLER SURVEY

Organization	Submittals
USAED, Tulsa ATTN: CESWT-EC-PF/London PO Box 61 Tulsa, OK 74121-0061	5 cys - all submittals
USAED, Southwestern ATTN: CESWD-ED-MM/Hasley 1114 Commerce Street Dallas, TX 75242-0216	1 cys - all submittals
Commander, USAFACAFS ATTN: ATZR-EE/Basham Bldg 1945 Fort Sill, OK 73503-7200	3 cys - all submittals
Commander, TRADOC ATTN: ATEN-FE/Capra Fort Monroe, VA 23651-5000	1 cys - all submittals
Commander, HQUSACE ATTN: CEMP-ET/Beranek 20 Massachusetts Ave NW Washington, DC 20314-1000	Executive Summaries only
HQDA ATTN: DALO-TSE/Maj Davies Pentagon Washington, DC 20310-0561	Executive Summaries only
USAED, Mobile ATTN: CESAM-EN-CC/Battaglia PO Box 2288 Mobile, AL 36628-0001	Final Submittal only

ANNEX C

REQUIRED DD FORM 1391 DATA

(Deleted)

ANNEX D

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Boiler Data. (Number, sizes, efficiency, etc.)

3. Present Energy Consumption.

   o Total Annual Energy Used.

   o Source Energy Consumption.

Electricity	- KWH, Dollars, BTU
Fuel Oil	- GALS, Dollars, BTU
Natural Gas	- THERMS, Dollars, BTU
Propane	- GALS, Dollars, BTU
Other	- QTY, Dollars, BTU

   o Energy Consumption by Systems.

4. Historical Energy Consumption.

5. Energy Conservation Analysis.

   o ECOs Investigated.

   o ECOs Recommended.

   o ECOs Rejected. (Provide economics or reasons)

   o ECIP Projects Developed. (Provide list)*

   o Non-ECIP Projects Developed. (Provide list)*

   o Operational or Policy Change Recommendations.

* Include the following data from the Life Cycle Cost Analysis Summary Sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date. For all programmed projects also include the year in which it is programmed and the programmed year cost.

6. Energy and Cost Savings.

   o Total Potential Energy and Cost Savings.

   o Percentage of Energy Conserved.

o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

7. Energy Plan.

   o Project Breakouts with Total Cost and SIR.

   o Schedule of Energy Conservation Project Implementation.

E M C ENGINEERS, INC.
2750 S. Wadsworth Blvd., Suite C-200
Denver, Colorado 80227
303/988-2951

CONFIRMATION NOTICE

CONFIRMATION NOTICE NO. 1

DATE: 5 July 1990

PROJECT: Central Energy Plant Study
Ft. Sill, Oklahoma

NOTES PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

DATE OF CONFERENCE: 4 June 1990

PLACE OF CONFERENCE: DEH Office, Ft. Sill, Oklahoma

PURPOSE OF CONFERENCE: Conference to discuss questions related to the Central Plant Study.

ATTENDEES: Carl E. Lundstrom, E M C Engineers, Inc.
Merle London, Tulsa District, COE
Jerry Schmidt, Ft. Sill DEH

CONFERENCE NOTES:

The following is a summary of the items discussed, the comments made, and the decisions made during the Conference.

1. The "Scope Reduction" pages were discussed. Mr. Schmidt agreed the scope reductions seemed reasonable in order to get the project within the project budget.

2. Mr. Lundstrom and Mr. London went through the original scope of services and made corrections, deletions, and changes related to the "Scope Reduction" pages.

3. Mr. London said he would revise the scope and mail a new request for proposal.

4. Mr. Lundstrom said he would start preparing a revised proposal.

FOR

Carl E. Lundstrom

cc: Merle London
Jerry Schmidt
Gary Basham
Carl Lundstrom

SCOPE REDUCTION

The following proposed scope changes to the "Energy Survey of Army Boiler and Chiller Plant For Ft. Sill, Oklahoma" are listed for Tulsa District's information.

TESTING:

CHILLER:

- o Eliminate cooling tower testing.
- o Reduce chiller testing metering to the minimum required to calculate efficiency performance at full load: chiller kW input, chilled water flow, chilled water supply and return temperature, condenser water flow, and condenser water supply and return temperature. Flow readings would be taken with ultrasonic flow meters.
- o The chiller testing would only involve measurements at one chilled water and one condenser water setpoint; plus taking the single point pressure, temperature, and kW measurements as originally indicated.
- o Interview operators and report condition.
- o Run chiller through operating range to observe conditions.
- o Observe cooling tower temperature control system.

BOILERS:

- o The boiler testing would involve
  - Taking orsat test (flue gas analysis measurements) while boilers is operating at low fire and high fire.
  - Record gas flow to boiler through existing meters if available.
  - Record temperature, pressure, and flow data through existing meters if available.
  - Correlate part load and full load capacity with manufacturers data and orsat test.
  - Interview operators and report condition of equipment.
  - Obtain operator log data that is available.

MEETINGS:

- o Eliminate the O&M training, and related materials.

ANALYSIS:

- o Eliminate 6 of 11 boiler energy conservation opportunities (ECO's) identified. ECO's left include:
  - Replacement of boilers.
  - Control systems.
  - Installation of new burners.

- Economizer/Air Preheater.
- High efficiency motors.

- Eliminate 5 of 10 chiller ECO's identified. ECO's left include:
  - Replacement of chillers.
  - Control systems.
  - Variable and two speed motors
  - Storage of chilled water or other thermal storage systems.
  - High efficiency motors.

- Eliminate all cooling tower ECO's.
- Eliminate cooling tower computer modeling
- Eliminate analysis of impact on existing chillers due to changing the refrigerant to an environmentally safe refrigerant and related requirements.

REPORT DEVELOPMENT:

- Eliminate programming document preparation.
- Eliminate implementation document preparation.
- Eliminate O&M training manual development.

[c:\jobs\p10f.12\scope.wp]

CONFIRMATION NOTICE

CONFIRMATION NOTICE NO. 2

DATE: 26 September 1990

PROJECT: Energy Survey of Army Boiler and Chiller Plants
Ft. Sill, Oklahoma
Contract No. DACA 56-90-C-0087

NOTICE
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

This is to confirm a conversation on 11 September 1990 between Merle London, Project Manager, Tulsa District Corps of Engineers, and Carl E. Lundstrom regarding documents related to the contract.

Mr. Lundstrom discussed with Mr. London that four sets of information were prepared and circulated during the negotiations of the referenced contract, which more clearly defined and refined the scope of services. Mr. Lundstrom wanted to reconfirm that these four documents are made part of the contract by this confirmation notice. The three documents are:

- Confirmation Notice No. 1, dated 5 July 1990, regarding "Scope Reductions."
- Conference Notes, dated 1 May 1990.
- Basis of Fee, submitted with fee proposal.
- Test Procedures, dated 14 June 1990.

Mr. London agreed the documents are part of the contract.

Carl E. Lundstrom, P.E.

CONFIRMATION NOTICE

Confirmation No. 3 EMC #3002.000

DATE: February 27, 1991

PROJECT: Energy Survey of Army Boiler and Chiller Plants
CONTRACT NO: DACA 56-90-C-0087

NOTICE
PREPARED BY: Pawn Chulavatr
E M C Engineers, Inc.

DATE OF
CONFERENCE: February 13, 1991

PLACE OF
CONFERENCE: Ft. Sill, Oklahoma

SUBJECT: Exit Interview Meeting Notes

ATTENDEES:	Merle London	Tulsa District COE	(918) 581-7991
	Serge Saltiel	DEH-Ft. Sill	(405) 351-5708
	Jerry Schmidt	DEH - Engineer Design	(405) 351-4250
	Carl Swenson	EMC Engineers, Inc.	(303) 988-2951
	Pawn Chulavatr	EMC Engineers, Inc.	(404) 952-3697

The following is a summary of items discussed, the comments made, and the decision made during the meeting.

EMC reported the preliminary results of the boiler survey. EMC stated that the combustion efficiency test of boilers went well and only one boiler is out of commission (building 4701). There were a few other minor problems encountered. Overall the test results were satisfactory. The preliminary result of the boiler testing is averaging around 77% efficiency.

Mr. Swenson suggests Ft. Sill train specialized groups of personnel in testing/calibrating boilers in all central plants. He expresses the lack of permanent instrumentation such as stack temperature gauge, pump pressure gauge, and opening for flue gas testing on boilers in the central plant. Mr. London asked that these suggestions be put in the report. EMC agreed to incorporate findings and suggestions into the report.

EMC described present operating procedures of boilers in the central plants according to the boiler operators. EMC reported that the only boiler log data was obtained from Central Plant 5900. The other central plants do not have log data.

Mr. Schmidt expressed interest in creating a central heating plant as an addition to chiller central plant in buildings 3442 and 730, utilizing existing underground piping.

Special Notes:

1. For the purpose of determining the base load on central plants, EMC is using the assumption that the proposed buildings listed for the EMCS in the DD1391 Validation Study will be connected to the EMCS. These buildings will incorporate day/night setback and other energy savings associated with EMCS.

2. EMC found the heating and cooling log data was either known to be false (stated by the operators) or upon checking, has been determined to be invalid. Because of the lack of this information, EMC will estimate the loads on the central plants based on BTU per square feet data obtained from previous studies. EMC will also use sound engineering judgment in applying the historical load data to the building and plants involved in this study.

If this method is unsatisfactory, EMC must be notified as soon as possible.

Pawn Chulavatr

Pawn Chulavatr

CONFERENCE NOTES

DATE: 26 September 1990

PROJECT: Energy Survey of Army Boiler and Chiller Plants
Ft. Sill, Oklahoma
Contract No. DACA 56-90-C-0087

NOTICE
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

DATE OF
CONFERENCE: 11 September 1990

PLACE OF CONFERENCE: DEH Conference Room, Ft. Sill, Oklahoma

PURPOSE OF CONFERENCE: Entry Interview

ATTENDEES: Merle London, Tulsa District, Corps of Engineers, (918) 581-7991
Carl Lundstrom, E M C Engineers, Inc., (404)952-3697
Carl Swenson, E M C Engineers, Inc., (303) 988-2951
Kenneth Rodgers, DEH HVAC, Ft. Sill
Jerry Schmidt, DEH, Ft. Sill, (405) 351-4250
Doug Cook, DEH Energy, Ft. Sill, (405) 351-3225

1. Mr. Lundstrom provided an overview of the scope of services, including testing, energy conservation opportunities (ECOs), and documentation of the plants to be evaluated.

2. Mr. Lundstrom described the test procedures to be conducted on the chillers and boilers. He described that the test on the chillers would be conducted immediately and the boiler testing would be conducted during winter months (December-February).

3. Mr. Lundstrom presented his list of personnel conducting the survey, his proposed schedule, and proposed working hours. Mr. Rodgers saw no problem providing RVAC shop personnel for the proposed survey schedule.

4. Mr. London discussed that EMC should be very careful when removing insulation, so as to not have asbestos problems. Mr. Lundstrom agreed with the situation. Mr. Schmidt agreed to contact Mr. Goode at Ft. Sill environmental regarding the testing of insulation for asbestos.

5. Mr. Lundstrom asked if it would be a problem to shut off chillers, or take load off of chillers temporarily so as to increase the load for testing purposes. Mr. Rodgers did not see a problem with this.

6. Mr. Swenson asked about the general condition of chillers and annual maintenance procedures. Mr. Rodgers explained the chillers are generally in good condition and the condensers are all cleaned before each cooling season.

7. Mr. Schmidt emphasized he is interested in adding more buildings to central plants, especially in those facilities where there is extra cooling capacity.

8. Mr. Cook discussed the Energy Department is interested in developing energy conservation projects for future funding.

9. Mr. Lundstrom agreed to prepare conference notes, and the meeting was adjourned.

Carl E. Lundstrom, P.E.

Enclosure: Meeting Agenda

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL
CONTRACT DACA56-90-C-0087

ENTRY INTERVIEW

AGENDA

1. GENERAL OVERVIEW OF PROJECT
- Testing of boiler and chillers for efficiency of plant.
- Determine current operating procedures of plants.
- Identify energy conservation opportunities (ECO).
- Perform analysis to determine energy consumption of plants, and evaluate ECO's.
- Prepare comprehensive report documenting the findings of the survey and analysis.
- Central Plants,
5900
6003
730
2812
5676
5678
3442
914
4701

2. INTENDED PROCEDURES
- Chiller Testing, September 1990
- Boiler Testing, January 1991
(see attached test procedures)

3. SCHEDULE - CHILLER TESTING
Tuesday, 9/11, Building 2812
Wednesday, 9/12, Building 6003
Thursday, 9/13, Building 730
Friday, 9/14, Building 730 & 914
Saturday, 9/15, Building 5900
Monday, 9/17, Building 5900
Tuesday, 9/18, Building 3442
Wednesday, 9/19, Building 5676
Thursday, 9/20, Building 5678
Friday, 9/21, Building 4701
Saturday, 9/22, optional
Monday, 9/24, optional

4. PERSONNEL CONDUCTING SURVEY

Carl E. Lundstrom
Carl A. Swenson
Jim Watters

5. PROPOSED WORKING HOURS

07:30 to 18:00 hours, dates as shown

6. DEH SUPPORT

One RVAC shop chiller personnel, to bring chillers on and off line for testing. Also EMC will interview RVAC personnel to determine how plants are currently operated.

7. DISCUSSION

Any chillers plants not operational that can not be tested?
Other

Date: 14 June 1990
EMC Project No.: P10E.012

[illegible] TESTING [illegible]

Boiler Testing:

The boiler test procedure is designed to determine the efficiency of the boiler plants. The procedure is based on the American Society of Mechanical Engineers (ASME) Power Test Code 4.1 and will utilize instrumentation provided by EMC Engineers, Inc. It is noted that this procedure does not strictly adhere to ASME PTC 4.1; it is designed to provide the necessary data while controlling costs. The data obtained during the testing will be used to analyze boiler-related Energy Conservation Opportunities (ECO's). A single reading of the following will be measured:

- Flue gas temperature
- Ambient (combustion) air temperature
- Flue gas CO_2 content
- Flue gas O_2 content
- Outside air temperature
- Outside air relative humidity
- Fuel flow (using existing meters)
- KW input to primary hot water circulation pumps
- Differential pressure on representative primary hot water circulation pumps

Boiler readings will be taken while the boiler is under steady state firing conditions to the extent practical. The test procedure is as follows:

1) Install Flue gas thermometer and sampling tube in the stack through existing penetrations if possible. If not, a new penetration will be made using a handheld drill.

2) For non modulating burners, set burner control to hi-fire setting (if applicable). Adjust controls of other boilers so that the boiler being tested fires continuously.

3) For modulating burners, set burner control to manual, constant setting. Adjust controls of other boilers so that the conditions of the boiler being tested remain relatively steady.[1]

4) Observe the following operating conditions relative to manufacturer's recommendations:

   - steam/hot water pressure/temperature setpoints
   - boiler water level

- flame configuration
- combustion control
- make-up water control
- leaking safety and other valves
- signs of leaking boiler tubes
- general condition of boiler insulation

5) Record data.

6) Remove instrumentation, return control settings to original positions.

Chiller Testing:

This chiller test procedure is made with the intent of determining the efficiency of the chiller plants. The procedure is based on the Air-Conditioning and Refrigeration Institute (ARI) Standard for Centrifugal or Rotary Screw Water-Chilling Packages (ARI 550-88). The procedure will utilize instrumentation provided by EMC Engineers, Inc. It is noted that this procedure does not strictly adhere to ARI 550-88; it is designed to provide the necessary data while controlling costs. The data obtained during the testing will be used to analyze chiller-related ECO's. A single set of readings of the following points will be metered:

- Condenser water inlet temperature
- Condenser water outlet temperature
- Chilled water return temperature
- Chilled water supply temperature
- Chilled water flow
- Chiller Compressor KW input
- Outside air temperature
- Outside air relative humidity
- KW input to chilled and condenser water pumps
- Differential pressure on representative chilled and condenser water pumps
- Condenser inlet/outlet pressure differential
- Evaporator inlet/outlet pressure differential

Readings will be taken at normal chilled water and condenser water supply temperature setpoints. "Normal setpoints" is meant to mean the setpoints used under normal operating conditions by the Ft. Sill maintenance staff. The test procedure is as follows:

1) Install all chiller test equipment.

2) Adjust setpoints to normal positions. Allow time for chiller to reach steady-state

conditions. Steady-state is considered to be established after three sets of data have been taken, at five minute intervals, where the readings remain within the tolerences set forth in ARI 550-88, Para. A7.2.

Practical steps will be taken to obtain steady-state conditions. If these conditions are not reached within 1 hour, the EMC test engineer will use his discretion as to how to proceed with the testing.

3) Have DEH personnel remove all non-condensables from the system.

4) During the testing, observe the following operating conditions relative to manufacturer's recommendations:

- refrigerant charge
- temperatures and pressures
- speed control

5) After the chiller conditions have stabilized, take a single set of readings.

6) Remove instrumentation.

At the time of the tests, DEH personnel will be interviewed as to the time of last cleaning and the general cleanliness of all heat exchangers. This information will be used to estimate fouling factors.

BASIS OF FEE

Energy Survey of Army Boiler and Chiller Plants
Ft. Sill, Oklahoma
Page 1 of 3

The proposal for the above project is based on the following items:

1. EMC will use existing natural gas meters in the boiler plants at Ft. Sill. EMC will not install any additional gas meters.

2. One complete set of metering equipment will be used. This equipment will all be direct readout type equipment; an electronic data acquisition system with sensors, PC, etc. will not be used. Equipment purchased for the project and to be given to the Government at the end of the project are as follows:

   - (2) Stack Thermometers

   - (1) Ultrasonic Flow Meter

   - (6) Thermometers

   - (1) Handheld Flue Gas Analyzer

   - (6) Pressure Gages

3. Asbestos Containing Materials (ACM) removal will amount to no more than (8) horizontal type 44" wide by 60" long glove bags.

4. Any material that is suspected by EMC to be ACM will be treated as ACM unless that material is sampled, tested, and positively identified by the Government as not being ACM. Sampling and testing must be performed according to all applicable EPA, OSHA, and other Federal, State, Regional, and Local regulations.

5. All ACM removal will be classified by EPA regulations as "O & M removal".

6. All ACM removed will be disposed of at the approved ACM disposal site at Ft. Sill.

7. All necessary pipe penetrations are existing. No additional pipe penetrations will be required for the testing.

8. Equipment outages of short duration will be required to connect meters. It is not expected that these outages will significantly effect plant operation. A general schedule of outages will be provided at the survey entrance interview. Given the nature of the survey work, providing a detailed schedule of outages is not possible.

9. In Appendix A, General Scope of Work, Para. 2.1, the phrase "updated and included" is taken to mean as follows: No technical analysis will be done under this contract. An

CONFERENCE NOTES

DATE: 1 May 1990

PROJECT: Ft. Sill
Energy Survey of Army Boiler and Chiller Plants

NOTES PREPARED BY: Carl E. Lundstrom, P.E.
E M C Engineers, Inc.

DATE OF CONFERENCE: 17 April 1990

PLACE OF CONFERENCE: DEH Office, Ft. Sill, Oklahoma

PURPOSE OF CONFERENCE: Pre-negotiation conference to discuss questions related to the Ft. Sill energy survey of Army boiler and chiller plants

ATTENDEES:
F. Mike Denham, E M C Engineers, Inc., (303)988-2951
Carl E. Lundstrom, E M C Engineers, Inc., (404)952-3697
Merle London, Tulsa District, COE, (918)581-7991
Gary W. Basham, Ft. Sill DEH, (405) 351-3517
Jerry E. Schmidt, Ft. Sill DEH, (405) 351-4250
Steve McManus, Ft. Sill Energy Conservation Office, (405) 351-3225
Ron Barnett, Environmental Division, (405) 351-2715
Don Goode, Environmental Division, (405) 351-2715

CONFERENCE NOTES:

The following is a summary of the items discussed, the comments made, and the decisions made during the Conference. The A/E statement of work and conference agenda were distributed to each person.

1. M. London opened the conference with general introductions and explanation of the scope of the project. EMC is to survey boilers and chillers at Ft. Sill, determine their operating efficiency, evaluate energy conservation opportunities, and prepare three submittals of the testing and analysis. In addition EMC is to provide a one-day training seminar.

2. Asbestos removal concerns were discussed with R. Barnett. EMC will be installing instrumentation on the boilers and chillers to test their efficiency. Piping and flue insulation will have to be removed. Unless the insulation has been sampled, tested and positively

identified as not having asbestos containing material (ACM), it will be treated as asbestos. Paragraph 2. in Annex B, in the statement of work, identifies the OSHA standard which must be followed by workers that will be in areas with ACM's. R. Barnett explained if ACM will be removed and disposed of, EMC must follow EPA regulation Title 40CFR 61 (m). It was felt the work would be classified as O&M removal. EMC should investigate inspection notification, ACM removal, and ACM disposal requirements. EMC will have to contract with a licensed ACM removal contractor for this work. The government has an approved ACM disposal site at Ft. Sill for the material.

The following questions relate to Appendix A, General Scope of Work for an Energy Survey of Army Boiler and Chiller Plants for Ft. Sill Oklahoma:

3. Paragraph 2.1: Only the previous studies identified in Annex 'B' paragraph 3.a.b.& c. and related projects in Annex 'B' attachment 1 (cont.) must be updated and included in this study.

4. Paragraph 2.3: The statement that the study shall include supporting systems such as fuel oil storage, pollution abatement, etc. is meant to only note those items related to the existing boiler and chiller plant, which seem not normal, in need of repair, etc. Detailed evaluation of these items is not required.

5. Paragraph 2.3: The study is not intended to include a detailed evaluation of the distribution systems related to the central plants. If EMC notes problems while on-site (such as steam leaks in piping pits) these items should be described briefly in the report.

6. Paragraph 2.5: The term "technically and economically feasible," is meant to be those items which have been done and proven to provide savings, i.e. nothing experimental. All ECO's should be coordinated with DEH on what's feasible for Ft. Sill.

7. Paragraph 2.8: ECAM evaluation does not apply to Ft. Sill. Delete this requirement from the statement of work.

8. Paragraph 3.4: EMC will not be required to attend any non-scheduled meetings. EMC will have a kickoff meeting at the beginning of the field survey, and an exit interview, plus the scheduled submittal review meetings.

9. Paragraph 3.7.1.c: There will be no major restrictions on the working hours for EMC. EMC shall coordinate it's working schedule with DEH.

10. Paragraph 7.1.1: The statement of work regarding "submit...testing laboratory to the Contracting Officer for approval, is meant to include submitting documentation showing testing equipment has been properly calibrated.

11. Paragraph 7.1.1: The efficiency testing requirements for boilers were divided into full testing, partial testing, and minimum testing requirements, based on the size and age of the plants (see Annex B - attachment 1).

Full efficiency testing is to include: Installation of instrumentation for input/output measurement required to meter energy in versus energy out. See attached diagrams for instrumentation of low temperature hot water boilers (LTHW), high temperature hot water boilers (HTHW), and steam boilers.

Partial efficiency testing is to include: Stack temperature and CO measurements to determine the boiler combustion efficiency, plus overall inspection of the general boiler condition and operation. See attached diagrams for instrumentation of low temperature hot water boilers (LTHW), high temperature hot water boilers (HTHW), and steam boilers.

Minimum testing is to include: Overall inspection of the general condition and operation. No instrumentation will be used for this testing.

It is assumed one set of instrumentation equipment will be used for the measurements. This set of instrumentation will be moved from boiler to boiler to make the required measurements. In those locations where an insertion flow meter will be used, a new pipe tap and full bore valve will be installed and left in place after the metering is complete.

EMC will be required to remove asbestos insulation on pipes and stacks as required to make measurements (see item 2.).

12. Paragraph 7.1.2: The efficiency testing requirements for chillers were divided into full testing, partial testing, and minimum testing requirements, based on the size and age of the plants (see Annex B - attachment 1).

Full efficiency testing is to include: Installation of instrumentation for input/output measurement required to meter energy in versus energy out. See attached diagrams for instrumentation of chillers.

Partial efficiency testing is to include: The same as full efficiency testing minus the flow metering installation. See attached diagrams for instrumentation of chillers.

Minimum testing is to include: Overall inspection of the general condition and operation. No instrumentation will be used for this testing.

It is assumed one set of instrumentation equipment will be used for the measurements. This set of instrumentation will be moved from

chiller to chiller to make the required measurements. In those locations where an insertion flow meter will be used, a new pipe tap and full bore valve will be installed and left in place after the metering is complete.

For the full and partial testing EMC will measure the efficiency of the plants at varying loads at the following setpoints:

- Chilled water supply setpoints: 44°, 46°, and 48°, at the normal condenser water setpoint temperature.
- Condenser water supply setpoints: 87, 85, and 82, at the normal chilled water supply setpoint temperature.

EMC will be required to remove asbestos insulation on pipes as required to make measurements (see item 2.).

13. Paragraph 7.2.3: This paragraph is not intended to write an O&M manual for boiler and chiller operation. Include O&M items which would be covered in the one-day training class related to this project.

14. Paragraph 7.5: It was decided $25,000 or less was the limit for a low cost/no cost ECO.

15. Paragraph 7.6.1: The sample completed DA Form 5108-R should be submitted with the interim submittal. EMC should coordinate with DEH which project should be submitted prior to the interim submittal.

16. Paragraph 8.: EMC will be required to give the one-day training class on three consecutive days, to three different classes of maintenance personnel at Ft. Sill. EMC should estimate on having 15 persons per class.

General comments and questions:

17. Mr. Lundstrom asked about evaluating manpower operation requirements. Mr. Basham explained this was a touchy subject, but is an important area to review. EMC should coordinate all information very closely with DEH, prior to submittals.

18. Mr. Lundstrom explained that to perform detailed ECO calculations, detailed boiler log data would provide the best method of estimating hourly loads. Because there are little or no log data kept, EMC will have to estimate loads, from gross capacities, or what little monthly metering data that's available.

19. After the study is complete, EMC will leave the metering equipment for government to use. There is little or no measurement or metering instrumentation on the central plants. This equipment can be used in the future for metering and adjusting central plant equipment operations. Some of the metering equipment will be site specific for the metering installations.

20. EMC will have to review the scheduling impact of: 1) submitting metering plan for approval, and 2) having contractors install metering taps and asbestos abatement.

21. Annex A, regarding impact of new refrigerants, EMC will address: 1) the general question of the affect refrigerant changes will have on Ft. Sill, and the central plants in question, 2) generally what efficiency, equipment changes, capacity, and life expectancy changes will occur, 3) manufacturers input to equipment changes required, 4) a general discussion on cost to convert chillers versus replacement of chillers, 5) life safety requirements for new refrigerants, and 6) general design guidelines and directives for future chiller plant designs. Specific chiller by chiller evaluation for technical modifications will not be provided in this study.

Ft. Sill DEH is to provide EMC with copies of the as-built mechanical plans for the chiller and boiler plants that will require instrumentation installations for measurement, for EMC to prepare a construction estimate for their fee proposal. Ft. Sill is to provide EMC a list of names of mechanical and asbestos abatement contractors who have worked at Ft. Sill.

Tulsa District needs to provide the following documents for EMC to prepare their fee proposal:

1. AR415-17, Tri-Service MCP Index, and EIRS bulletin.
2. Latest ECIP guidance.
3. AR5-4, change no. 1.
4. ETL 1110-3-332.
5. AR415-15, MCP Data, DD Form 1391
6. AR415-20.
7. TM5-800-3 for PDB.
8. Copy of a completed PDB.
9. DA Form 5108-R, copy of a blank form, instructions for completing the form, and a completed form as an example.
10. Copy of a completed DA Form 5108-R.
11. Example completed implementation document

Carl E. Lundstrom, P.E.
Project Manager

[C:\JOBS\SILL\CONFNOTE.WP]

economic analysis will be done using the previous technical analysis results and current economic data. Construction cost estimates from the previous studies will be adjusted for inflation. All necessary technical analysis results from the previous studies will be provided by the Government. Only previous studies that effect the boiler/chiller plants in this study and that are identified in Annex B, Attachment 1, Detailed Scope of Work will be included in this study.

10. The manufacturer's published technical data will be sufficient certification of accuracy for meters and other test equipment that are new (not previously used).

11. EMC will have the full-time assistance of a boiler/chiller operator from Ft. Sill to perform equipment changeover. This will require approximately 1-1/2 weeks during the chiller testing in July or August 1990 and approximately 1 week during the boiler testing in January 1991.

12. Annex A to the General Scope of Work "General Energy Conservation Opportunities and Other Considerations" is revised to eliminate redundant ECO's and to combine certain ECO's to allow for practical implementation and valid technical analysis. Annex A will read as follows:

    General Energy Conservation Opportunities:

    1) Replacement of Boilers
    2) Installation of New Burners and Control Systems (to assure proper combustion air-fuel ratio and most economical operation, including equipment optimization)
    3) Economizers/Air Preheaters
    4) High Efficiency Motors on Primary Hot Water Circulation Pumps and Chilled and Condenser Water Pumps.
    5) Variable or Two Speed Motors on Primary Hot Water Circulation Pumps and Chilled and Condenser Water Pumps.
    6) Replacement of Chillers
    7) Control Systems (to operate chillers at most economical conditions, including equipment optimization)
    8) Storage of Chilled Water

13. No additional ECO's will be analyzed in detail. No ECAM projects will be included. A general discussion of possible low cost / no cost ECO's observed during the surveys will be included in the report.

14. No heating or electrical load calculations are included. These loads will be provided by the Government, as required.

15. EMC project team members will make four trips to Ft. Sill. They are as follows:

    1) Chiller testing (approximately 1-1/2 weeks)
    2) Boiler testing (approximately 1 week)
    3) Interim Report Submittal Presentation
    4) Prefinal Report Submittal Presentation

16. No more than two EMC personnel will take part in each site visit to Ft. Sill. This includes the surveys and the submittal presentations.

17. Boiler/Chiller plants 5900, 6003, and 730 are included.

18. Travel costs were established based on 14 day prior notice.

Any additional effort to that indicated above will be accomplished through a modification to the contract.

8.15.91

FORT SILL REVIEW COMMENTS

DIRECTORATE OF ENGINEERING & HOUSING

PROJECT	BOILER/CHILLER SURVEY
LOCATION	FORT SILL
PROJECT NUMBER	
DATE	
DISCIPLINE	☐ CIVIL ☐ ARCHITECTURAL ☐ MECHANICAL ☐ ELECTRICAL ☐ FIRE PROTECTION ☒ M P
REVIEWER	SERGE SALTIEL
PHONE NUMBER	(405) 351-~~4250~~ 5708

ACTION

A CONCUR
D DO NOT CONCUR
E EXCEPTION
X DELETE
(EXPLAIN D, E, & X)

ACTION BY

COMPLY

CMT. NO.	DWG. NO. OR REF.	REVIEWER SERGE SALTIEL	COMPLY	
		EXECUTIVE SUMMARY		
1.	ES 2	THIS ANALYSIS SHOULD BE INDEPENDENT OF THE EMCS. CAN NOT ASSUME THAT THE EMCS WILL BE INSTALLED	✓	
2	ES 3	THIS STUDY SHOULD VALIDATE IF A CENTRAL PLANT ADDITION TO 3442 IS A GOOD PROJECT	✓	
3	ES 3/4	OPERATIONAL NOTES TO SAVE ENERGY WITH LOW OR NO COST ARE TOO GENERAL.	✓	
4	ES 5	STATEMENT ABOUT THE 3442 PLANT ADD. (SAME AS COMM. 2) MUST BE VALIDATED TO SEE IF WE SHOULD INCLUDE IN THE BRKS PROJECT.	✓	
5	ES 8	ECO LIST SHOWS 17 ITEMS DESCRIPTIONS ARE NOT CLEAR EXAMPLE; #1 & 7. HOW IS ESTABLISHING CHILLER & BOILER LOAD GOING TO SAVE ENERGY?	✓	

PAGE 1 OF ___

L 836 Army—Fort Sill, Okla.

FS Form 910
(DEH) 1 Aug 87

FORT SILL REVIEW COMMENTS	DATE 17 JUL 91	ACTION A CONCUR D DO NOT CONCUR E EXCEPTION X DELETE (EXPLAIN D, E, & X)
DIRECTORATE OF ENGINEERING & HOUSING	DISCIPLINE ☐ CIVIL ☐ ARCHITECTURAL ☐ MECHANICAL ☐ ELECTRICAL ☐ FIRE PROTECTION ☒ MP	
PROJECT BOILER/CHILLER SURVEY		ACTION BY
LOCATION FORT SILL / PROJECT NUMBER		
CMT. NO. / DWG. NO. OR REF. / REVIEWER SERGE SALTIEL	PHONE NUMBER (405) 351-4250	COMPLY

CMT. NO.	DWG. NO. OR REF.	REVIEWER		
6	ES10	ECO NO 8 FOR BLDG 730 SHOWS AN SIR OF 2.2 & A PAYBACK OF 8 YEARS, HOWEVER ON TABLE ES-7 (PAGE ES21) THE SAME ECO IS SHOWN AS NOT FEASIBLE	WILL CORRECT TABLE ES-4 PAGE ES-10 ✓	
7	ES18/19	NEGATIVE PAYBACK YEARS IS MEANINGLESS. Use "NA"	✓	
8		GENERAL COMMENT. THE EXECUTIVE SUMMARY MUST RELATE THE OVERALL FINDINGS OF THE SURVEY, HOWEVER IT MUST CONTAIN SPECIFIC DESCRIPTION OF EACH RECOMMENDATION FOR THE "EXECUTIVE" TO MAKE DECISIONS WITHOUT GOING TROUGH THE BACK-UP REPORTS. RECOMMENDATIONS ARE VERY GENERAL & PROPOSED SCOPE OF PROJECTS TOO HARD TO FOLLOW.	✓	

PAGE 2 OF ____

L 836 Army—Fort Sill, Okla.

FS Form 910
(DEH) 1 Aug 87

FORT SILL REVIEW COMMENTS	DATE 8 July, 1991	ACTION A CONCUR D DO NOT CONCUR E EXCEPTION X DELETE (EXPLAIN D, E & X)
DIRECTORATE OF ENGINEERING & HOUSING ENERGY SURVEY OF ARMY BOILER & CHILLER PLANTS	DISCIPLINE CIVIL ARCHITECTURAL XX MECHANICAL ELECTRICAL FIRE PROTECTION	
LOCATION: FORT SILL, OKLAHOMA PROJECT NUMBER: DACA 56-90-C-0087		ACTION BY
CMT. NO. / DWG. NO. / REVIEWER: JERRY SCHMIDT	PHONE NUMBER (405)351-4250	COMPLY

VOLUME 1

CMT. NO.	DWG. NO.	Comment	Action
1.	2-19	Paragraph 2.2.4 The chillers in central plant building 3442 serves a total of 21 buildings.	✓
2.	2-34	Paragraph 2.2.8 and Paragraph 2.2.8.2 The central plant building 5900 serves a total of 5 barracks (bldgs. no. 5955, 5960, 5970, 6007 & 6050).	✓
3.	2-45	Central plant chiller should be 370 tons Table 2-2 shows chiller to be 170 tons.	✓
4.	2-46	Central plant (No. 5676) chiller should be 375 tons Table 2-2 shows chiller to be 170 tons.	VERIFY
5.	3-2	The distribution loss for the area served by the central plant in building have been more than negligible. The heat loss from the super heated hot water distribution system have caused sufficient ground heating to damaged some of the chilled water piping. If the ground heat was sufficient to cause damage to plastic piping systems then it stands to reason that the losses are more than negligible. Ground temp 155F w/ boilers on.	VERIFY FOR HTH ✓ DISREGARD FOR CHW
6.	Tab 4	Annual savings for Ice Storage Systems was based on 12 months per year and the existing chiller efficiency. The use of Air Conditioning is only authorized 4 to 5 months per year and the existing chillers, modified to produce ice, will lose efficiency. The savings should be based on the actual period of use and the efficiency achieved while producing ice.	NA
7.	4-47	The estimated construction cost to replace the existing gas chiller appears to be excessive.	NA
8.	6-5	The chiller located at central plant 914 is a 400 ton chiller.	✓
9.	6-13	The central plant 6003 has three chillers one 400 ton and two 450 ton chillers. The operational strategies only addressed using the two 450 ton chillers.	✓

L 836 Army-Fort Sill, Okla.

FS Form 910
(DEH) 1 Aug 87

FORT SILL REVIEW COMMENTS	DATE 8 July, 1991	ACTION
DIRECTORATE OF ENGINEERING & HOUSING	DISCIPLINE CIVIL ARCHITECTURAL XX MECHANICAL ELECTRICAL FIRE PROTECTION	A CONCUR D DO NOT CONCUR E EXCEPTION X DELETE (EXPLAIN D, E & X)
ENERGY SURVEY OF ARMY BOILER & CHILLER PLANTS		
LOCATION FORT SILL, OKLAHOMA — PROJECT NUMBER DACA 56-90-C-0087		ACTION BY
CMT. NO. / DWG. NO. / REVIEWER JERRY SCHMIDT	PHONE NUMBER (405)351-4250	COMPLY

10. 7-2	Brief description on ECO would be beneficial at this point.	✓	
VOLUME II			
11. C-3	Building 5900 chiller 4 should be listed as a 450 ton chiller.	✓	
EXECUTIVE SUMMARY			
12.	The executive summary should have included recommendation concerning the CFC issue. The base has a large number of chillers that would be affected by CFC legislation.	✓	

L 836 Army-Fort Sill, Okla.

FS Form 910

CONFIRMATION NOTICE

Confirmation No. 4 | EMC #3002.000

DATE: 19 August 1991

PROJECT: Energy Survey of Central Plants, Ft. Sill, Oklahoma
CONTRACT NO.: DACA56-90-C-0087

NOTES PREPARED BY: Carl Lundstrom
E M C Engineers, Inc.

DATE OF CONFERENCE: 15 August 1991

PLACE OF CONFERENCE: Tulsa District Resident Engineer's Office

SUBJECT: Interim Review Conference Presentation and Comments Review

ATTENDEES:
W. Wayne Kiser, DEH (405) 351-5708
Merle London, Tulsa District COE (918) 581-7991
Carl E. Lundstrom, EMC Engineers, Inc. (404) 952-3697
Gene Paulsgrove, DEH Master Planning (405) 351-5708
Kenneth Rogers, DEH (405) 351-5910
Serge Saltiel, DEH (405) 351-5708
Jerry Schmidt, DEH Engr. Design (405) 351-4250
Carl Swenson, EMC Engineers (303) 988-2951

The following is a summary of the items discussed, the comments made, and the decisions made during the Conference:

1. Mr. London made introductions and passed roster to attendees.

2. Mr. Lundstrom made a presentation of the Interim Submittal:

   - Survey Findings.
   - ECO Analysis.
   - Conclusions and Recommendations.

Based on the discussion of the presentation, the following items were concluded and project direction was determined:

- Review electrical rates to verify electric demand rate charges.
- ECO 3, Central Plant 914, repair chiller to increase efficiency: This ECO has been done under warranty service.
- ECO 4, Central Plant 914, ice storage: This ECO was rejected; savings are marginal.
- ECO 3, Central Plant 2812, replace chiller: This ECO was not economically justified as a replacement project. To repair the existing chiller is not an acceptable alternative.
- ECO 17, Central Plants 730 and 2812, electric water heaters: This ECO was rejected, because Ft. Sill does not want to do any projects which may increase the Fort's overall summer electrical demand.
- ECO 3, Central Plant 4701, replace chiller: This ECO was not economically justified as a replacement project. To repair the existing chillers is not an acceptable alternative.
- ECO 4, Central Plant 4701, ice storage: This ECO was rejected because of marginal savings.
- RDF boiler, Central Plant 5900: This special project to update a previous study was rejected because of current refuse quantities and operation of the plant.
- ECO 9, Central Plant 5900, replace boilers: This ECO will be investigated in place of the proposed repair project.
- ECO 12, Central Plant 5900, stack economizers: This ECO was rejected because or the potential increase in manpower to support operations.
- Central Plant 3442, service extension to provide cooling to Buildings 2470 and 2471: This special project is not required because these two buildings have new chiller equipment.
- ECO 6, high efficiency motors, all plants: In place of further analysis, it should be noted that high efficiency motors should be installed if replacements are justified.
- ECO 10, boiler combustion controls, all plants: No further analysis or consideration is required, because of the concern regarding the marginal savings and high maintenance requirements.

3. The Ft. Sill DEH engineers conferred as to proposed ECOs to develop into projects for the final submittal.

   Based on their discussion, the following projects were developed:

   Project A:
   Boiler and chiller controls project (ECOs 1, 2, 7, and 8) for Central Plants 730, 914, 2812, 3442, 5676, 5678, 5900, and 6003. The control project is to be a stand-alone project, and the savings or costs should not assume an EMCS exists.

   Project B:
   Central heating plant replacement project at Central Plant 5900, boilers 1 and 2, and Central Plant 2812, boilers 1 and 2.

   Project C:
   One new central plant to provide heating and cooling to both Buildings 5676 and 5678.

   In preparing the final analysis, Ft. Sill DEH engineers requested the energy analysis be based on the assumption the EMCS was not installed. Mr. Lundstrom agreed to use non-EMCS loads to prepare the final analysis. The Ft. Sill DEH engineers asked that the computer input for the final project energy analysis be included with the final report. Mr. Lundstrom agreed to provide this information.

4. Additional analysis comparison:

   - Compare central heating plant at 3442, to individual boilers at each building. Consider plant to also serve Buildings 2470 and 2471. Do not consider using chilled water lines for distribution from heating plant.

Carl E. Lundstrom
/rt

If any portion of this Confirmation Notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 10 days, it will be assumed that the decisions and conclusions, and status outlined in this Confirmation Notice is correct.

CONFERENCE NOTICE

EMC #3002.000

Conformation No. 5

DATE: 10 September 1991

PROJECT: Energy Survey of Army Boiler and Chiller Plants Ft. Sill, Oklahoma
CONTRACT No. DACA 56-90-C-0087

NOTICE PREPARED BY: Kamchornvuthi Chulavatr
E M C Engineers, Inc.

DATE OF CONFERENCE: 6 September 1991

PLACE OF CONFERENCE: Public Work Center, Mr. Howard Hovis office, Ft. Sill, Oklahoma

SUBJECT: To discuss central plant's control strategy and projects to be evaluated in the study

ATTENDEES: W. Wayne Keiser, DEH, Ft. Sill (405) 351-5708
Serge Saltiel, DEH, Ft. Sill (405) 351-5708
Jerry Schmidt, DEH, Ft. Sill, (405) 351-4250
Howard Hovis, PWC, Ft. Sill, (405) 351-3608/5341
Kamchornvuthi Chulavatr, E M C Engineers, Inc., (404) 952-3697

The following is a summary of the items discussed, the comments made, and the decisions made during the conference.

The control and monitoring points for central plants will include the following:

Boiler
- Natural gas line pressure before and after the regulator
- Flow and accumulative of the make-up water
- Boiler stack temperature and O_2
- Boilers alarm
- Pumps start/stop and status
- Supply and return water temperatures
- Flow of the supply steam and hot water
- Supply pressure for steam and nitrogen in the expansion tank for high temperature hot water
- LEDs display

<u>Chiller</u>

- Pumps start/stop and status
- Supply and return chilled water and condenser water temperatures
- Flow of the chilled water
- Chiller start/stop and status
- Cooling towers start/stop and status
- Chiller kW consumption
- LEDs display

Projects to be evaluated are:

- Project 1. - Control project for central plant 730, 5900, and 6003.
- Project 2. - Central plant project and control project for building 5676 and 5678.
- Project 3. - Replace boiler number 1 and 2 in central plant 2812 and 5900.
- Project 4. - Replace a chiller in central plant 2812 with the small higher efficiency chiller.
- Project 5. - Compare local hot water boiler in each barracks versus central heating plant project for 3442.

The following are result of general item discussed:

- The control project will include the fiber optics DTM cost from the central pant to RVAC shop, building 1950.
- There will not be any new control projects for central plant 914, 2812, and cooling plant 3442.
- The central computer for the control project will be an existing PC located in the RVAC shop, and, if possible, use existing software.

Kamchornvuthi Chulavatr

Kamchornvuthi Chulavatr

If any portion of this conformation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this notice are correct.

CONFIRMATION NOTICE

EMC# 3002.000

Confirmation No. 6

DATE: 9 March 1992

PROJECT: Energy Survey of Army Boiler and Chiller Plants
Ft. Sill, Oklahoma

CONTRACT NO: DACA56-90-C-0087

NOTES PREPARED BY: Carl E. Lundstrom
EMC Engineers, Inc.

DATE OF CONFERENCE: 5 March 1992

PLACE OF CONFERENCE: Mr. Kiser's Office, Dept. of Public Works
Ft. Sill, OK

SUBJECT: To discuss results of the Prefinal report.

ATTENDEES:
Carl Lundstrom, EMC Engineers, Inc. (404) 952-3697
Merle London, Tulsa District COE (918)-581-7991
Jerry Schmidt, Ft. Sill DPW, Engineering Design (405)-351-4250
Howard Hovis, Ft. Sill DPW, Chief FMD, (405) 351-3608
Gene Paulsgrove, Ft. Sill DPW, Planning, (405) 351-5708
W. Wayne Kiser, Ft. Sill DPW, Chief Engineering Division, (405) 351-5708

The following is a summary of the items discussed, the comments made, and the decisions made during the conference:

1. Mr. Lundstrom explained EMC finished and submitted the Prefinal report in October 1991.

2. Mr. Lundstrom reviewed the results of the evaluation of the five projects developed from the Interim Submittal.

3. Mr. Lundstrom went over the review comments made by Jerry Schmidt. Mr. Lundstrom confirmed he would make the following revisions to the final submittal:

   o Distribution losses for chilled water lines will be included in the project energy calculations for Central Plants 6003 and 5900.

- o Project 2: (Central Plants 5676 and 5678) will be reviewed as a heating plant replacement project only, with the idea of chiller plant replacement in the future.

- o Comments regarding Project 4 are not applicable, since the chiller is being replaced under a current construction project.

Carl E. Lundstrom

Carl E. Lundstrom, P.E.

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

SILL REVIEW COMMENTS	DATE 6 November, 1991	ACTION
DIRECTORATE OF PUBLIC WORKS	DISCIPLINE	A CONCUR
ENERGY SURVEY OF ARMY BOILER & CHILLER PLANTS	CIVIL	D DO NOT CONCUR
	ARCHITECTURAL	E EXCEPTION
	XX MECHANICAL	X DELETE
LOCATION: FORT SILL, OKLAHOMA — PROJECT NUMBER: DACA 56-90-C-0087	ELECTRICAL	(EXPLAIN D, E & X)
	FIRE PROTECTION	
CMT. NO. / DWG. NO. / REVIEWER: JERRY SCHMIDT	PHONE NUMBER (405)351-4250	ACTION BY ----- -----

VOLUME 1

1. 3-2 The distribution loss for the area served by the central plant in building 5900 and 6003 have been more than negligible. The heat loss from the super heated hot water and steam distribution systems have caused sufficient ground heating to damaged some of the chilled water piping; by causing ovaling, blistering and collapse of the plastic chilled water piping. If the ground heat was sufficient to cause damage to plastic piping systems then it stands to reason that the losses are more than negligible. — A

2. Section 6, paragraph 6.2.1
The Central Plant at building 730 has three CHILLERS, two 300 tons and one 800 tons. Chiller Optimization should utilize all three chillers. For low load conditions of 0 to 300 tons, one 300 tons chiller. Medium load of 300 to 600 tons, two 300 tons chillers. High load of 600 to 800 tons, one 800 tons chiller. Peak load of 800 tons and above, one 800 tons and one 300 tons chillers. This strategy will have the chillers operating at 70 to 80 percent of there peak capacity (the most economical portion of there efficiency curve) the majority of there operating time. — A

3. Section 8, paragraph 8.1.2
The difference in cost of a central plant and replacing the existing equipment is what should be compared. — X

VOLUME II

4. C-3 (Reference Review Comment number 11 dated 8 July 1991.)

Building 5900 chiller 4 should be listed as a 450 ton chiller. — A

VOLUME III

5. J.1.8 The drawing indicates that there may be adequate space in the existing mechanical room for the heating and cooling equipment, if one chiller is used, thus eliminated the need for the addition to the building. — X

L 836 Army-Fort Sill, Okla.

FS Form 910
(DEH) 1 Aug 87

SILL REVIEW COMMENTS	DATE 6 November, 1991	ACTION
DIRECTORATE OF PUBLIC WORKS	DISCIPLINE	A CONCUR
ENERGY SURVEY OF ARMY BOILER & CHILLER PLANTS	CIVIL	D DO NOT CONCUR
	ARCHITECTURAL	E EXCEPTION
	XX MECHANICAL	X DELETE
LOCATION: FORT SILL, OKLAHOMA — PROJECT NUMBER: DACA 56-90-C-0087	ELECTRICAL	(EXPLAIN D, E & X)
	FIRE PROTECTION	
CMT. NO. / DWG. NO. / REVIEWER: JERRY SCHMIDT	PHONE NUMBER (405)351-4250	ACTION BY ----- -----

CMT. NO.	DWG. NO.	COMMENT	ACTION
6.	J.1.4 & J.1.5	If the scope is reduced from two chillers to one chiller and eliminating the addition to the building the project bare cost could be reduces approximately $200,000. (Building addition $120,000 Chiller $80,000)	A
7.	L.1.4	If the chiller sizing is based on the combined load of the connected buildings (Reference Volume II page B-5) 305.7 Tons and a diversity factor of 0.85 used the chiller size should be 260 Tons. This down sizing of the chiller from 342 Tons to 260 Tons should increase the energy savings and lower the cost of the chiller without altering the comfort level in the buildings.	X

L 836 Army-Fort Sill, Okla.

APPENDIX B

BASE LOAD DATA

AND MISCELLANEOUS CALCULATIONS

HEATING AND COOLING LOADS
OF
REPRESENTATIVE BUILDINGS

REPRESENTATIVE BUILDING INFORMATION

11-Apr-91

XXX = BUIDING TYPE WITH EMCS
XXX-N = BUIDING TYPE WITHOUT EMCS

MONTH	BLDG. TYPE	BARRACK	BARRACK-N	OFFICE	OFFICE-N	CLUB	CLUB-N
	BLDG. NO	3411	3411	3161	3161	3281	3281
	SQ. FT	8246	8246	6500	6500	27526	27526
	PEAK LIGHTING (KW)	27	27	2	2	34	34
JANUARY	**PEAK HEATING (BTU/H)**	3.59E+05	3.66E+05	1.46E+05	1.49E+05	9.28E+05	9.28E+05
	PEAK COOLING (BTU/H)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	HEATING (MBTU)	216.00	235.00	45.29	74.96	316.00	441.00
	COOLING (T-kWH)	0.00	0.00	0.00	0.00	0.00	0.00
	LIGHTING (kWH)	9.54	9.54	0.63	0.63	14.65	14.65
	PROCESS (MBTU)	1.70	1.70	3.28	3.28	127.12	127.12
FEBRUARY	**PEAK HEATING (BTU/H)**	3.12E+05	3.25E+05	1.27E+05	1.32E+05	8.06E+05	8.06E+05
	PEAK COOLING (BTU/H)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	HEATING (MBTU)	147.00	166.00	30.03	53.64	205.00	298.00
	COOLING (T-kWH)	0.00	0.00	0.00	0.00	0.00	0.06
	LIGHTING (kWH)	8.61	8.61	0.55	0.55	13.23	13.23
	PROCESS (MBTU)	1.53	1.53	2.86	2.86	114.82	114.82
MARCH	**PEAK HEATING (BTU/H)**	3.25E+05	3.39E+05	1.32E+05	1.38E+05	8.41E+05	8.41E+05
	PEAK COOLING (BTU/H)	3.99E+04	6.30E+04	1.59E+04	1.59E+04	2.02E+05	1.05E+05
	HEATING (MBTU)	100.00	119.00	19.32	38.04	125.00	195.00
	COOLING (T-kWH)	0.09	0.34	0.00	0.07	1.63	2.39
	LIGHTING (kWH)	9.54	9.54	0.61	0.61	14.65	14.65
	PROCESS (MBTU)	1.70	1.70	3.14	3.14	127.12	127.12
APRIL	**PEAK HEATING (BTU/H)**	2.44E+05	2.57E+05	9.91E+04	1.05E+05	6.31E+05	6.31E+05
	PEAK COOLING (BTU/H)	1.32E+05	1.49E+05	3.55E+04	3.49E+04	2.76E+05	2.32E+05
	HEATING (MBTU)	10.11	13.96	3.01	8.56	11.00	28.00
	COOLING (T-kWH)	1.23	2.35	0.16	0.45	6.77	9.05
	LIGHTING (kWH)	9.23	9.23	0.58	0.58	14.18	14.18
	PROCESS (MBTU)	1.64	1.64	3.00	3.00	123.01	123.01
MAY	**PEAK HEATING (BTU/H)**	0.00E+00	0.00E+00	4.68E+04	8.25E+04	2.98E+05	2.98E+05
	PEAK COOLING (BTU/H)	1.63E+05	1.77E+05	5.68E+04	4.17E+04	4.77E+05	2.93E+05
	HEATING (MBTU)	0.00	1.27	0.30	1.58	1.00	1.69
	COOLING (T-kWH)	4.43	6.45	0.61	1.33	15.45	20.06
	LIGHTING (kWH)	9.54	9.54	0.63	0.63	14.65	14.65
	PROCESS (MBTU)	1.70	1.70	3.28	3.28	127.12	127.12
JUNE	**PEAK HEATING (BTU/H)**	0.00E+00	0.00E+00	3.85E+04	3.85E+04	0.00E+00	0.00E+00
	PEAK COOLING (BTU/H)	1.96E+05	2.07E+05	1.17E+05	5.25E+04	5.82E+05	3.44E+05
	HEATING (MBTU)	0.00	0.00	0.03	0.61	0.00	0.00
	COOLING (T-kWH)	11.55	13.25	1.66	3.20	27.30	35.86
	LIGHTING (kWH)	9.23	9.23	0.58	0.58	14.18	14.18
	PROCESS (MBTU)	1.64	1.64	3.00	3.00	123.01	123.01

REPRESENTATIVE BUILDING INFORMATION

11-Apr-91

XXX = BUIDING TYPE WITH EMCS
XXX-N = BUIDING TYPE WITHOUT EMCS

MONTH	BLDG. TYPE	BARRACK	BARRACK-N	OFFICE	OFFICE-N	CLUB	CLUB-N
	BLDG. NO	3411	3411	3161	3161	3281	3281
	SQ. FT	8246	8246	6500	6500	27526	27526
	PEAK LIGHTING (KW)	27	27	2	2	34	34
JULY	**PEAK HEATING (BTU/H)**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.30E+01
	PEAK COOLING (BTU/H)	1.98E+05	2.07E+05	1.17E+05	5.02E+04	5.82E+05	4.23E+05
	HEATING (MBTU)	0.00	0.00	0.00	0.00	0.00	0.00
	COOLING (T-kWH)	13.99	15.64	2.16	3.97	33.07	43.04
	LIGHTING (kWH)	9.54	9.54	0.61	0.61	14.65	14.65
	PROCESS (MBTU)	1.70	1.70	3.14	3.14	127.12	42.95
AUGUST	**PEAK HEATING (BTU/H)**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	PEAK COOLING (BTU/H)	2.07E+05	2.07E+05	1.17E+05	4.94E+04	5.82E+05	4.21E+05
	HEATING (MBTU)	0.00	0.00	0.00	0.00	0.00	0.00
	COOLING (T-kWH)	14.15	15.77	2.02	3.89	32.57	42.95
	LIGHTING (kWH)	9.54	9.54	0.63	0.63	14.65	15.00
	PROCESS (MBTU)	1.70	1.70	3.28	3.28	127.12	127.12
SEPTEMBER	**PEAK HEATING (BTU/H)**	0.00E+00	0.00E+00	3.30E+04	3.03E+04	2.10E+05	2.10E+05
	PEAK COOLING (BTU/H)	1.91E+05	2.04E+05	1.17E+05	4.72E+04	5.82E+05	3.92E+05
	HEATING (MBTU)	0.00	0.00	0.19	1.13	0.00	1.00
	COOLING (T-kWH)	9.17	10.95	1.20	2.40	22.21	29.12
	LIGHTING (kWH)	9.23	9.23	0.56	0.56	14.18	14.18
	PROCESS (MBTU)	1.64	1.64	2.87	2.87	123.01	123.01
OCTOBER	**PEAK HEATING (BTU/H)**	1.22E+05	2.17E+05	4.95E+04	8.80E+04	3.15E+05	3.15E+05
	PEAK COOLING (BTU/H)	1.84E+05	1.98E+05	8.02E+04	3.76E+04	5.77E+05	3.51E+05
	HEATING (MBTU)	0.17	3.47	5.51	8.66	8.00	20.00
	COOLING (T-kWH)	1.91	3.39	0.20	0.56	7.70	10.94
	LIGHTING (kWH)	9.54	9.54	0.63	0.63	14.65	14.65
	PROCESS (MBTU)	1.70	1.70	3.28	3.28	127.12	127.12
NOVEMBER	**PEAK HEATING (BTU/H)**	2.10E+05	2.24E+05	8.53E+04	9.08E+04	5.43E+05	5.43E+05
	PEAK COOLING (BTU/H)	0.00E+00	3.52E+04	0.00E+00	0.00E+00	1.33E+05	1.54E+05
	HEATING (MBTU)	63.00	78.00	15.62	32.13	84.00	142.00
	COOLING (T-kWH)	0.00	0.04	0.00	0.00	0.35	0.77
	LIGHTING (kWH)	9.23	9.23	0.61	0.61	14.18	14.18
	PROCESS (MBTU)	1.64	1.64	3.14	3.14	123.01	123.01
DECEMBER	**PEAK HEATING (BTU/H)**	2.85E+05	2.98E+05	1.16E+05	1.21E+05	7.36E+05	7.36E+05
	PEAK COOLING (BTU/H)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	HEATING (MBTU)	154.00	174.00	33.75	62.31	225.00	337.00
	COOLING (T-kWH)	0.00	0.00	0.00	0.00	0.00	0.00
	LIGHTING (kWH)	9.54	9.54	0.58	0.58	14.65	14.65
	PROCESS (MBTU)	1.70	1.70	3.01	3.01	127.12	127.12

BUILDING SERVED BY CENTRAL PLANT
AND THEIR PEAK HEATING/COOLING

BUILDING CONNECTED TO CENTRAL PLANT

11-Apr-91

Energy Plant	Bldg Number	Bldg Name	Bldg use	Bldg SF	Bldg MBH	Bldg ton	Similar Bldg	Ratio of Sq. Ft
5900 *	6007	BARRACK	BARRACK	189290	8.97	383.0	3411	22.96
			OFFICE	18945			3161	2.91
			CLUB	12520			3281	0.45
*	6050	BARRACK	BARRACK	189290	7.47	383.0	3411	22.96
			OFFICE	18945			3161	2.91
			CLUB	12520			3281	0.45
*	5955	BARRACK	BARRACK	189290	7.47	383.0	3411	22.96
			OFFICE	18945			3161	2.91
			CLUB	12520			3281	0.45
*	5960	BARRACK	BARRACK	189290	7.47	383.0	3411	22.96
			OFFICE	18945			3161	2.91
			CLUB	12520			3281	0.45
*	5970	BARRACK	BARRACK	189290	7.47	383.0	3411	22.96
			OFFICE	18945			3161	2.91
			CLUB	12520			3281	0.45
*	5900	ENERGY PLT	BARRACK	1500	3.03	0.0	3411	0.18
		ENERGY PLANT TOTAL			42	1915	22.98	
6003	6002	ADMINIS.	OFFICE-N	23671	0.44	19.0	3161	3.64
*	6003	ENERGY PLT	BARRACK	0	0.40	0.0	3411	0.00
	6004	ADMINIS.	OFFICE-N	23671	0.44	19.0	3161	3.64
	6009	BARRACK	BARRACK-N	34872	1.71	76.0	3411	4.23
	6010	BARRACK	BARRACK-N	34872	1.71	76.0	3411	4.23
*	6011	MESS HALL	CLUB	17121	4.64	134.0	3281	0.62
	6012	BARRACK	BARRACK-N	78121	1.71	152.0	3411	9.47
	6014	BARRACK	BARRACK-N	34872	1.71	76.0	3411	4.23
	6015	BARRACK	BARRACK-N	34872	1.71	76.0	3411	4.23
	6017	BARRACK	BARRACK-N	69744	0.52	46.0	3411	8.46
	6018	BARRACK	BARRACK-N	69744	1.71	152.0	3411	8.46
*	6120	CLASSROOM	OFFICE	15988	0.91	30.0	3161	2.46
	6080	STORE HS.	OFFICE-N	1372	0.16	32.0	3161	0.21
		ENERGY PLANT TOTAL			18	888	10.66	
730 *	700	CLASSROOM	OFFICE	146599	4.22	362.0	3161	22.55
*	707	CLASSROOM	OFFICE	77010	2.22	198.0	3161	11.85
*	730	CLASSROOM	OFFICE	214072	5.79	570.0	3161	32.93
*	840	CLASSROOM	OFFICE	142459	2.36	0.0	3161	21.92
		ENERGY PLANT TOTAL			14.5918	1130	13.56	
2812	2811	MESS HALL	CLUB-N	9192	0.41	41.0	3281	0.33
	2838	BARRACK	BARRACK-N	13132	0.40	18.7	3411	1.59
	2839	BARRACK	BARRACK-N	13132	0.40	18.7	3411	1.59
	2841	BARRACK	BARRACK-N	13132	0.40	18.7	3411	1.59
	2842	BARRACK	BARRACK-N	13132	0.40	18.7	3411	1.59
	2844	BARRACK	OFFICE	13132	0.40	18.7	3161	2.02
	2845	BARRACK	OFFICE	13132	0.40	18.7	3161	2.02
	2846	BARRACK	OFFICE	13132	0.40	18.7	3161	2.02
	2847	BARRACK	BARRACK-N	13132	0.40	18.7	3411	1.59
	2854	BARRACK	BARRACK-N	13132	0.40	18.7	3411	1.59
	2856	BARRACK	BARRACK-N	13132	0.40	18.7	3411	1.59
	2857	BARRACK	BARRACK-N	13132	0.40	18.7	3411	1.59
	2858	DAY ROOM	OFFICE	12084	0.43	40.0	3161	1.86
	2859	BARRACK	BARRACK-N	13132	0.40	19.0	3411	1.59
		ENERGY PLANT TOTAL			5.61	305.70	3.67	

BUILDING CONNECTED TO CENTRAL PLANT

11-Apr-91

Energy Plant	Bldg Number	Bldg Name	Bldg use	Bldg SF	Bldg MBH	Bldg ton	Similar Bldg	Ratio of Sq. Ft
5676 *	5676	BARRACK	BARRACK	89660.8	3.28	155.1	3411	10.87
		BARRACK	OFFICE	17932.2			3161	2.76
					3.28	155.10	1.86	
5678 *	5678	BARRACK	BARRACK	103333	3.91	201.6	3411	12.53
		BARRACK	OFFICE	20666.7			3161	3.18
					3.91	201.60	2.42	
3442 *	3411	BARRACK	BARRACK	36569	1.26	61.9	3411	4.43
*	3412	BARRACK	BARRACK	36569	1.26	61.9	3411	4.43
*	3413	BARRACK	BARRACK	36569	1.26	61.9	3411	4.43
*	3414	BARRACK	BARRACK	36569	1.26	61.9	3411	4.43
*	3415	BARRACK	BARRACK	36569	1.26	61.9	3411	4.43
*	3416	BARRACK	OFFICE	36569	1.26	61.9	3161	5.63
*	3417	BARRACK	OFFICE	36569	1.26	61.9	3161	5.63
*	3418	BARRACK	OFFICE	36569	1.26	61.9	3161	5.63
*	3419	BARRACK	OFFICE	36569	1.26	61.9	3161	5.63
*	3420	BARRACK	OFFICE	36569	1.26	61.9	3161	5.63
*	3421	BARRACK	OFFICE	36569	1.26	61.9	3161	5.63
*	3422	BARRACK	OFFICE	36569	1.26	61.9	3161	5.63
*	3423	BARRACK	BARRACK-N	36569	1.26	61.9	3411	4.43
*	3424	BARRACK	BARRACK-N	36569	1.26	61.9	3411	4.43
*	3425	BARRACK	BARRACK-N	36569	1.26	61.9	3411	4.43
*	3426	BARRACK	BARRACK-N	36569	1.26	61.9	3411	4.43
*	3427	BARRACK	BARRACK-N	36569	1.26	61.9	3411	4.43
	3428	BARRACK	BARRACK-N	36569	1.26	61.9	3411	4.43
	3429	BARRACK	BARRACK-N	36569	1.26	61.9	3411	4.43
	3430	BARRACK	BARRACK-N	36569	1.26	61.9	3411	4.43
	3440	BARRACK	BARRACK-N	36569	1.26	61.9	3411	4.43
		ENERGY PLANT TOTAL			26.38	1299.90	15.60	
914	900	BARRACK	OFFICE-N	61498	1.86	82.0	3161	9.46
	912	BARRACK	OFFICE-N	97470	2.72	120.0	3161	15.00
	913	BARRACK	OFFICE-N	96029	2.52	118.0	3161	14.77
	914	BARRACK	BARRACK	82462.5	2.86	118.0	3411	10.00
		ENERGY PLANT TOTAL			2.86	438.00	5.26	
4701 *	4700	ADMINIS.	OFFICE	197112	4.2584	423.1	3161	30.32
					4.26	423.10	5.08	

ESTIMATED MONTHLY HEATING LOAD
LISTED BY CENTRAL PLANT

MONTHLY HEATING LOADS

03-Apr-92 CENTRAL-.WK3

ENERGY PLANT	MONTH	(A) PEAK HEATING (BTU/H)	(B) DISTRIB. LOSSES (BTU/H)	(C) DOMESTIC HW@80% (BTU/H)	(D) (B)+(C) (BTU/H)	(E)=(D+A) TOTAL PEAK HEATING (BTU/H)	(F) HEATING CONSUMPT (MMBTU)	(G) DISTRIB. LOSSES (MMBTU)	(H) HW LOAD (MMBTU)	(I) (B)+(C) (MMBTU)	(J)=(F+I) TOTAL HEATING (MMBTU)
730	JANUARY	14,591,800	156,400	409,862	566,262	15,158,062	6,602	116	40	156	6,758
	FEBRUARY	14,591,800	156,400	409,862	566,262	15,158,062	4,724	105	36	141	4,865
	MARCH	14,591,800	156,400	409,862	566,262	15,158,062	3,350	116	40	156	3,506
	APRIL	9,247,715	156,400	409,862	566,262	9,813,978	754	113	38	151	905
	MAY	7,266,062	156,400	409,862	566,262	7,832,324	139	116	40	156	295
	JUNE	3,390,829	156,400	409,862	566,262	3,957,091	54	113	38	151	205
	JULY	0	156,400	409,862	566,262	566,262	0	116	40	156	156
	AUGUST	0	156,400	409,862	566,262	566,262	0	116	40	156	156
	SEPTEMBER	2,668,626	156,400	409,862	566,262	3,234,889	100	113	38	151	251
	OCTOBER	7,750,466	156,400	409,862	566,262	8,316,728	763	116	40	156	919
	NOVEMBER	7,997,072	156,400	409,862	566,262	8,563,334	2,830	113	38	151	2,981
	DECEMBER	14,591,800	156,400	409,862	566,262	15,158,062	5,488	116	40	156	5,644
	TOTAL	14,591,800									
	DESIGN	14,591,800									
914	JANUARY	2,857,400	0	1,288,000	1,288,000	4,145,400	530	0	16	16	546
	FEBRUARY	2,857,400	0	1,288,000	1,288,000	4,145,400	374	0	14	14	388
	MARCH	2,857,400	0	1,288,000	1,288,000	4,145,400	268	0	16	16	284
	APRIL	579,531	0	1,288,000	1,288,000	1,867,531	31	0	15	15	47
	MAY	0	0	1,288,000	1,288,000	1,288,000	3	0	16	16	19
	JUNE	0	0	1,288,000	1,288,000	1,288,000	0	0	15	15	15
	JULY	0	0	1,288,000	1,288,000	1,288,000	0	0	16	16	16
	AUGUST	0	0	1,288,000	1,288,000	1,288,000	0	0	16	16	16
	SEPTEMBER	0	0	1,288,000	1,288,000	1,288,000	0	0	15	15	15
	OCTOBER	489,331	0	1,288,000	1,288,000	1,777,331	8	0	16	16	24
	NOVEMBER	505,116	0	1,288,000	1,288,000	1,793,116	176	0	15	15	191
	DECEMBER	2,857,400	0	1,288,000	1,288,000	4,145,400	392	0	16	16	408
	TOTAL	2,857,400									
	DESIGN	2,857,400									

MONTHLY HEATING LOADS

CENTRAL-.WK3

03-Apr-92 ENERGY PLANT	MONTH	(A) PEAK HEATING (BTU/H)	(B) DISTRIB. LOSSES (BTU/H)	(C) DOMESTIC HW@80% (BTU/H)	(D) (B)+(C) (BTU/H)	(E)=(D+A) TOTAL PEAK HEATING (BTU/H)	(F) HEATING CONSUMPT (MMBTU)	(G) DISTRIB. LOSSES (MMBTU)	(H) HW LOAD (MMBTU)	(I) (B)+(C) (MMBTU)	(J)=(F+I) TOTAL HEATING (MMBTU)
2812	JANUARY	5,610,300	240,800	2,015,726	2,256,526	7,866,826	1,492	179	378	557	2,049
	FEBRUARY	5,610,300	240,800	2,015,726	2,256,526	7,866,826	1,055	162	342	504	1,558
	MARCH	5,610,300	240,800	2,015,726	2,256,526	7,866,826	747	179	378	557	1,304
	APRIL	1,860,573	240,800	2,015,726	2,256,526	4,117,100	121	173	366	539	661
	MAY	743,641	240,800	2,015,726	2,256,526	3,000,167	17	179	378	557	574
	JUNE	300,893	240,800	2,015,726	2,256,526	2,557,419	5	173	366	539	544
	JULY	14	240,800	2,015,726	2,256,526	2,256,541	0	179	378	557	557
	AUGUST	0	240,800	2,015,726	2,256,526	2,256,526	0	179	378	557	557
	SEPTEMBER	306,481	240,800	2,015,726	2,256,526	2,563,007	9	173	366	539	549
	OCTOBER	1,493,592	240,800	2,015,726	2,256,526	3,750,118	86	179	378	557	643
	NOVEMBER	1,613,745	240,800	2,015,726	2,256,526	3,870,271	550	173	366	539	1,090
	DECEMBER	5,610,300	240,800	2,015,726	2,256,526	7,866,826	1,161	179	378	557	1,719
	TOTAL	5,610,300									
	DESIGN	5,610,300									
3442	JANUARY	28,897,200	0	0	0	28,897,200	5,405	0	0	0	5,405
	FEBRUARY	28,897,200	0	0	0	28,897,200	3,818	0	0	0	3,818
	MARCH	28,897,200	0	0	0	28,897,200	2,737	0	0	0	2,737
	APRIL	5,911,000	0	0	0	5,911,000	321	0	0	0	321
	MAY	0	0	0	0	0	29	0	0	0	29
	JUNE	0	0	0	0	0	0	0	0	0	0
	JULY	0	0	0	0	0	0	0	0	0	0
	AUGUST	0	0	0	0	0	0	0	0	0	0
	SEPTEMBER	0	0	0	0	0	0	0	0	0	0
	OCTOBER	4,991,000	0	0	0	4,991,000	80	0	0	0	80
	NOVEMBER	5,152,000	0	0	0	5,152,000	1,794	0	0	0	1,794
	DECEMBER	28,897,200	0	0	0	28,897,200	4,002	0	0	0	4,002
	TOTAL	28,897,200									
	DESIGN	28,897,200									

MONTHLY HEATING LOADS

CENTRAL-.WK3

03-Apr-92

ENERGY PLANT	MONTH	(A) PEAK HEATING (BTU/H)	(B) DISTRIB. LOSSES (BTU/H)	(C) DOMESTIC HW@80% (BTU/H)	(D) (B)+(C) (BTU/H)	(E)=(D+A) TOTAL PEAK HEATING (BTU/H)	(F) HEATING CONSUMPT (MMBTU)	(G) DISTRIB. LOSSES (MMBTU)	(H) HW LOAD (MMBTU)	(I) (B)+(C) (MMBTU)	(J)=(F+I) TOTAL HEATING (MMBTU)
4701	JANUARY	4,258,400	11,160	860,509	871,669	5,130,069	1,355	8	100	108	1,464
	FEBRUARY	4,258,400	11,160	860,509	871,669	5,130,069	899	7	90	98	996
	MARCH	4,258,400	11,160	860,509	871,669	5,130,069	578	8	100	108	686
	APRIL	2,965,508	11,160	860,509	871,669	3,837,176	90	8	97	105	195
	MAY	1,400,462	11,160	860,509	871,669	2,272,131	9	8	100	108	117
	JUNE	1,152,089	11,160	860,509	871,669	2,023,758	1	8	97	105	106
	JULY	0	11,160	860,509	871,669	871,669	0	8	100	108	108
	AUGUST	0	11,160	860,509	871,669	871,669	0	8	100	108	108
	SEPTEMBER	987,505	11,160	860,509	871,669	1,859,174	6	8	97	105	110
	OCTOBER	1,481,258	11,160	860,509	871,669	2,352,926	165	8	100	108	273
	NOVEMBER	2,552,551	11,160	860,509	871,669	3,424,220	467	8	97	105	572
	DECEMBER	4,258,400	11,160	860,509	871,669	5,130,069	1,010	8	100	108	1,118
	TOTAL	4,258,400									
	DESIGN	4,258,400									
5676	JANUARY	3,278,700	0	0	0	3,278,700	780	0	0	0	780
	FEBRUARY	3,278,700	0	0	0	3,278,700	553	0	0	0	553
	MARCH	3,278,700	0	0	0	3,278,700	395	0	0	0	395
	APRIL	630,119	0	0	0	630,119	58	0	0	0	58
	MAY	224,594	0	0	0	224,594	7	0	0	0	7
	JUNE	104,811	0	0	0	104,811	2	0	0	0	2
	JULY	0	0	0	0	0	0	0	0	0	0
	AUGUST	0	0	0	0	0	0	0	0	0	0
	SEPTEMBER	82,487	0	0	0	82,487	3	0	0	0	3
	OCTOBER	532,046	0	0	0	532,046	32	0	0	0	32
	NOVEMBER	549,209	0	0	0	549,209	279	0	0	0	279
	DECEMBER	3,278,700	0	0	0	3,278,700	596	0	0	0	596
	TOTAL	3,278,700									
	DESIGN	3,278,700									

MONTHLY HEATING LOADS

CENTRAL-.WK3

03-Apr-92 ENERGY PLANT	MONTH	(A) PEAK HEATING (BTU/H)	(B) DISTRIB. LOSSES (BTU/H)	(C) DOMESTIC HW@80% (BTU/H)	(D) (B)+(C) (BTU/H)	(E)=(D+A) TOTAL PEAK HEATING (BTU/H)	(F) HEATING CONSUMPT (MMBTU)	(G) DISTRIB. LOSSES (MMBTU)	(H) HW LOAD (MMBTU)	(I) (B)+(C) (MMBTU)	(J)=(F+I) TOTAL HEATING (MMBTU)
5678	JANUARY	3,907,800	0	0	0	3,907,800	899	0	0	0	899
	FEBRUARY	3,907,800	0	0	0	3,907,800	637	0	0	0	637
	MARCH	3,907,800	0	0	0	3,907,800	456	0	0	0	456
	APRIL	726,207	0	0	0	726,207	66	0	0	0	66
	MAY	258,843	0	0	0	258,843	9	0	0	0	9
	JUNE	120,793	0	0	0	120,793	2	0	0	0	2
	JULY	0	0	0	0	0	0	0	0	0	0
	AUGUST	0	0	0	0	0	0	0	0	0	0
	SEPTEMBER	95,066	0	0	0	95,066	4	0	0	0	4
	OCTOBER	613,179	0	0	0	613,179	37	0	0	0	37
	NOVEMBER	632,959	0	0	0	632,959	321	0	0	0	321
	DECEMBER	3,907,800	0	0	0	3,907,800	687	0	0	0	687
	TOTAL	3,907,800									
	DESIGN	3,907,800									
5900	JANUARY	41,880,000	2,800,998	13,257,360	16,058,358	57,938,358	8,165	2,084	1,569	3,653	11,818
	FEBRUARY	41,880,000	2,800,998	13,257,360	16,058,358	57,938,358	5,747	1,882	1,417	3,299	9,046
	MARCH	41,880,000	2,800,998	13,257,360	16,058,358	57,938,358	4,072	2,084	1,569	3,653	7,725
	APRIL	6,661,480	0	13,257,360	13,257,360	19,918,840	548	0	1,518	1,518	2,066
	MAY	1,186,399	0	13,257,360	13,257,360	14,443,759	0	0	1,569	1,569	1,569
	JUNE	553,653	939,251	13,257,360	14,196,611	14,750,264	0	676	1,518	2,195	2,195
	JULY	97	0	13,257,360	13,257,360	13,257,457	0	0	1,569	1,569	1,569
	AUGUST	0	0	13,257,360	13,257,360	13,257,360	0	0	1,569	1,569	1,569
	SEPTEMBER	474,499	0	13,257,360	13,257,360	13,731,859	0	0	1,518	1,518	1,518
	OCTOBER	5,621,227	0	13,257,360	13,257,360	18,878,587	260	0	1,569	1,569	1,829
	NOVEMBER	5,806,005	2,800,998	13,257,360	16,058,358	21,864,363	2,804	2,017	1,518	3,535	6,339
	DECEMBER	41,880,000	2,800,998	13,257,360	16,058,358	57,938,358	6,167	2,084	1,569	3,653	9,820
	TOTAL	41,880,000									
	DESIGN	41,880,000									

MONTHLY HEATING LOADS

CENTRAL-.WK3

03-Apr-92

ENERGY PLANT	MONTH	(A) PEAK HEATING (BTU/H)	(B) DISTRIB. LOSSES (BTU/H)	(C) DOMESTIC HW@80% (BTU/H)	(D) (B)+(C) (BTU/H)	(E)=(D+A) TOTAL PEAK HEATING (BTU/H)	(F) HEATING CONSUMPT (MMBTU)	(G) DISTRIB. LOSSES (MMBTU)	(H) HW LOAD (MMBTU)	(I) (B)+(C) (MMBTU)	(J)=(F+I) TOTAL HEATING (MMBTU)
6003	JANUARY	17,770,000	975,451	5,064,000	6,039,451	23,809,451	3,304	726	682	1,408	4,711
	FEBRUARY	17,770,000	975,451	5,064,000	6,039,451	23,809,451	2,332	656	616	1,271	3,604
	MARCH	17,770,000	975,451	5,064,000	6,039,451	23,809,451	1,656	726	682	1,408	3,064
	APRIL	3,930,934	722,183	5,064,000	5,786,183	9,717,117	238	520	660	1,180	1,418
	MAY	994,528	722,183	5,064,000	5,786,183	6,780,711	29	537	682	1,219	1,248
	JUNE	378,173	722,183	5,064,000	5,786,183	6,164,356	6	520	660	1,180	1,186
	JULY	27	722,183	5,064,000	5,786,183	5,786,210	0	537	682	1,219	1,219
	AUGUST	0	722,183	5,064,000	5,786,183	5,786,183	0	537	682	1,219	1,219
	SEPTEMBER	427,402	722,183	5,064,000	5,786,183	6,213,585	12	520	660	1,180	1,192
	OCTOBER	3,178,067	722,183	5,064,000	5,786,183	8,964,250	131	537	682	1,219	1,351
	NOVEMBER	3,414,824	975,451	5,064,000	6,039,451	9,454,275	1,165	702	660	1,362	2,527
	DECEMBER	17,770,000	975,451	5,064,000	6,039,451	23,809,451	2,519	726	682	1,408	3,927
	TOTAL	17,770,000									
	DESIGN	17,770,000									

ESTIMATED MONTHLY COOLING LOAD
LISTED BY CENTRAL PLANT

MONTHLY COOLING LOADS

06–Apr–92

ENERGY PLANT	MONTH	(A) PEAK COOLING (BTU/H)	(B)=(A*0.8) PEAK W/80% DIVERSITY (BTU/H)	(C) COOLING CONSUMPT. (1000kWH)	(D)=C*1000*3413/1,000,000 COOLING CONSUMPT. (MMBTU)
730	JANUARY	0	0	0	0
	FEBRUARY	0	0	0	0
	MARCH	1,402,260	1,121,808	6	21
	APRIL	3,073,411	2,458,729	40	135
	MAY	3,669,513	2,935,611	117	400
	JUNE	13,560,000	10,848,000	282	962
	JULY	13,560,000	10,848,000	350	1,193
	AUGUST	13,560,000	10,848,000	343	1,169
	SEPTEMBER	13,560,000	10,848,000	211	721
	OCTOBER	3,308,239	2,646,591	49	168
	NOVEMBER	0	0	0	0
	DECEMBER	0	0	0	0
	TOTAL	13,560,000			
	DESIGN	13,560,000			
914	JANUARY	0	0	0	0
	FEBRUARY	0	0	0	0
	MARCH	758,406	606,725	3	12
	APRIL	1,685,942	1,348,754	23	78
	MAY	2,012,044	1,609,635	66	225
	JUNE	5,256,000	4,204,800	154	525
	JULY	5,256,000	4,204,800	189	645
	AUGUST	5,256,000	4,204,800	186	635
	SEPTEMBER	5,256,000	4,204,800	118	401
	OCTOBER	1,901,149	1,520,919	29	100
	NOVEMBER	79,417	63,533	0	0
	DECEMBER	0	0	0	0
	TOTAL	5,256,000			
	DESIGN	5,256,000			

MONTHLY COOLING LOADS

06-Apr-92

ENERGY PLANT	MONTH	(A) PEAK COOLING (BTU/H)	(B)=(A*0.8) PEAK W/80% DIVERSITY (BTU/H)	(C) COOLING CONSUMPT. (1000kWH)	(D)=C*1000*3413/1,000,000 COOLING CONSUMPT. (MMBTU)
2812	JANUARY	0	0	0	0
	FEBRUARY	0	0	0	0
	MARCH	362,934	290,347	2	8
	APRIL	829,961	663,968	14	48
	MAY	994,775	795,820	38	129
	JUNE	3,668,400	2,934,720	80	272
	JULY	3,668,400	2,934,720	96	327
	AUGUST	3,668,400	2,934,720	96	326
	SEPTEMBER	3,668,400	2,934,720	64	218
	OCTOBER	1,050,627	840,502	19	65
	NOVEMBER	164,994	131,996	0	1
	DECEMBER	0	0	0	0
	TOTAL	3,668,400			
	DESIGN	3,668,400			
3442	JANUARY	0	0	0	0
	FEBRUARY	0	0	0	0
	MARCH	1,448,872	1,159,098	8	27
	APRIL	3,417,316	2,733,853	54	184
	MAY	4,070,993	3,256,795	148	506
	JUNE	17,084,400	13,667,520	305	1,040
	JULY	17,084,400	13,667,520	360	1,228
	AUGUST	17,084,400	13,667,520	363	1,238
	SEPTEMBER	17,084,400	13,667,520	252	860
	OCTOBER	4,559,566	3,647,653	78	266
	NOVEMBER	810,021	648,016	1	3
	DECEMBER	0	0	0	0
	TOTAL	17,084,400			
	DESIGN	17,084,400			

MONTHLY COOLING LOADS

06-Apr-92		(A)	(B)=(A*0.8)	(C)	(D)=C*1000*3413/1,000,000
ENERGY PLANT	MONTH	PEAK COOLING (BTU/H)	PEAK W/80% DIVERSITY (BTU/H)	COOLING CONSUMPT. (1000kWH)	COOLING CONSUMPT. (MMBTU)
4701	JANUARY	0	0	0	0
	FEBRUARY	0	0	0	0
	MARCH	476,441	381,152	0	0
	APRIL	1,060,900	848,720	5	16
	MAY	1,700,947	1,360,758	18	62
	JUNE	5,077,200	4,061,760	50	170
	JULY	5,077,200	4,061,760	65	221
	AUGUST	5,077,200	4,061,760	60	206
	SEPTEMBER	5,077,200	4,061,760	36	123
	OCTOBER	2,398,862	1,919,089	6	20
	NOVEMBER	0	0	0	0
	DECEMBER	0	0	0	0
	TOTAL	5,077,200			
	DESIGN	5,077,200			
5676	JANUARY	0	0	0	0
	FEBRUARY	0	0	0	0
	MARCH	154,451	123,561	1	3
	APRIL	364,290	291,432	7	24
	MAY	433,973	347,178	19	66
	JUNE	1,861,200	1,488,960	41	141
	JULY	1,861,200	1,488,960	49	168
	AUGUST	1,861,200	1,488,960	49	168
	SEPTEMBER	1,861,200	1,488,960	33	114
	OCTOBER	486,055	388,844	10	34
	NOVEMBER	86,349	69,079	0	0
	DECEMBER	0	0	0	0
	TOTAL	1,861,200			
	DESIGN	1,861,200			

MONTHLY COOLING LOADS

06-Apr-92

ENERGY PLANT	MONTH	(A) PEAK COOLING (BTU/H)	(B)=(A*0.8) PEAK W/80% DIVERSITY (BTU/H)	(C) COOLING CONSUMPT. (1000kWH)	(D)=C*1000*3413/1,000,000 COOLING CONSUMPT. (MMBTU)
5678	JANUARY	0	0	0	0
	FEBRUARY	0	0	0	0
	MARCH	178,004	142,403	1	4
	APRIL	419,841	335,873	8	27
	MAY	500,150	400,120	22	76
	JUNE	2,419,200	1,935,360	47	162
	JULY	2,419,200	1,935,360	57	193
	AUGUST	2,419,200	1,935,360	57	194
	SEPTEMBER	2,419,200	1,935,360	38	131
	OCTOBER	560,174	448,139	11	39
	NOVEMBER	99,517	79,613	0	0
	DECEMBER	0	0	0	0
	TOTAL	2,419,200	1,935,360	242	827
	DESIGN	2	2		
5900	JANUARY	0	0	0	0
	FEBRUARY	0	0	0	0
	MARCH	1,632,010	1,305,608	15	52
	APRIL	3,850,831	3,080,665	88	300
	MAY	6,514,764	5,211,811	2,159	7,368
	JUNE	22,980,000	18,384,000	8,879	30,305
	JULY	22,980,000	18,384,000	2,487	8,487
	AUGUST	22,980,000	18,384,000	2,489	8,494
	SEPTEMBER	22,980,000	18,384,000	2,311	7,888
	OCTOBER	5,138,309	4,110,647	121	412
	NOVEMBER	911,492	729,193	3	9
	DECEMBER	0	0	0	0
	TOTAL	22,980,000			
	DESIGN	22,980,000			

MONTHLY COOLING LOADS

06-Apr-92

ENERGY PLANT	MONTH	(A) PEAK COOLING (BTU/H)	(B)=(A*0.8) PEAK W/80% DIVERSITY (BTU/H)	(C) COOLING CONSUMPT. (1000kWH)	(D)=C*1000*3413/1,000,000 COOLING CONSUMPT. (MMBTU)
6003	JANUARY	0	0	0	0
	FEBRUARY	0	0	0	0
	MARCH	836,554	669,243	5	19
	APRIL	1,937,143	1,549,714	33	112
	MAY	4,041,274	3,233,019	1,811	6,182
	JUNE	10,656,000	8,524,800	1,906	6,504
	JULY	10,656,000	8,524,800	1,941	6,625
	AUGUST	10,656,000	8,524,800	1,941	6,626
	SEPTEMBER	10,656,000	8,524,800	1,871	6,387
	OCTOBER	2,521,534	2,017,227	45	155
	NOVEMBER	439,220	351,376	1	3
	DECEMBER	0	0	0	0
	TOTAL	10,656,000			
	DESIGN	10,656,000			

MONTHLY CENTRAL PLANT ENERGY CONSUMPTION
AND
ELECTRICAL DEMAND

12–Apr

BASELINE

BLDG NO.	RUN NO.	ENERGY USAGE	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
730	RUN 1	GAS CONSM. (MCF)	6092	4450	2993								2443	5010	20988
		ELEC.DEMAND (kW)	525	525	525	525	525	525	525	525	525	525	525	525	6300
		ELEC.CONSM. (kWH)	31000	25000	23000		143000	140000	169000	158000	143000		23000	28000	883000
	RUN 2	GAS CONSM. (MCF)				224	235	205	235	224	224	235			1582
		ELEC.DEMAND (kW)	130	130	130	130	130	130	130	130	130	130	130	130	1560
		ELEC.CONSM. (kWH)				43000	12000	10000	11000	11000	11000	46000			144000
914	RUN 1	GAS CONSM. (MCF)	3121	3197	2213								1371	3435	13337
		ELEC.DEMAND (kW)	286	286	286	286	286	286	286	286	286	286	286	286	3432
		ELEC.CONSM. (kWH)					73000	117000	138000	137000	98000				563000
	RUN 2	GAS CONSM. (MCF)	44	39	44	42	44	42	44	44	42	44	42	44	515
		ELEC.DEMAND (kW)													
		ELEC.CONSM. (kWH)													
2812	RUN 1	GAS CONSM. (MCF)	7351	6124	4512								3330	6134	27451
		ELEC.DEMAND (kW)	192	192	192	192	192	192	192	192	192	192	192	192	2304
		ELEC.CONSM. (kWH)	11000	10000	11000		65000	87000	97000	98000	79000		11000	11000	480000
	RUN 2	GAS CONSM. (MCF)				1030	1064	1030	1064	1064	1030	1064			7346
		ELEC.DEMAND (kW)	8	8	8	8	8	8	8	8	8	8	8	8	96
		ELEC.CONSM. (kWH)				5000	6000	5000	6000	6000	5000	6000			39000
	RUN 3	GAS CONSM. (MCF)	284	263	291	282	291	280	291	291	282	291	281	291	3418
		ELEC.DEMAND (kW)													
		ELEC.CONSM. (kWH)													
3442	RUN 1	GAS CONSM. (MCF)													
		ELEC.DEMAND (kW)	590	590	590	590	590	590	590	590	590	590	590	590	7080
		ELEC.CONSM. (kWH)					203000	274000	308000	308000	247000				1340000
4701	RUN 1	GAS CONSM. (MCF)	2164	1672	1166								997	1877	7876
		ELEC.DEMAND (kW)	396	396	396	396	396	396	396	396	396	396	396	396	4752
		ELEC.CONSM. (kWH)					61000	56000	66000	62000	61000				306000
	RUN 2	GAS CONSM. (MCF)				239	252	242	250	243	242	252			1720
		ELEC.DEMAND (kW)													
		ELEC.CONSM. (kWH)													
5676	RUN 1	GAS CONSM. (MCF)	4201	2927	1964								1296	3074	13462
		ELEC.DEMAND (kW)	165	165	165	165	165	165	165	165	165	165	165	165	1980
		ELEC.CONSM. (kWH)					35000	63000	75000	75000	51000				299000
5678	RUN 1	GAS CONSM. (MCF)	4226	3817	2976								1582	3729	16330
		ELEC.DEMAND (kW)	106	106	106	106	106	106	106	106	106	106	106	106	1272
		ELEC.CONSM. (kWH)					34000	48000	54000	55000	42000				233000
5900	RUN 1	GAS CONSM. (MCF)	49169	36204	27867								20512	38503	172255
		ELEC.DEMAND (kW)	1886	1886	1886	1886	1886	1886	1886	1886	1886	1886	1886	1886	22632
		ELEC.CONSM. (kWH)					192000	476000	595000	598000	363000				2224000
6003	RUN 1	GAS CONSM. (MCF)	20309	15009	11800								8592	15913	71623
		ELEC.DEMAND (kW)	417	417	417	417	417	417	417	417	417	417	417	417	5004
		ELEC.CONSM. (kWH)					155000	199000	221000	221000	181000				977000
	RUN 2	GAS CONSM. (MCF)				2997	3098	2997	3098	3098	2997	3098			21383
		ELEC.DEMAND (kW)													
		ELEC.CONSM. (kWH)													

HISTORICAL WEATHER DATA AT FT. SILL

HISTORICAL DATA
OF
HEATING AND COOLING PERIOD
AT FT. SILL, OKLAHOMA

[H-C-DAYS.WK3]

Year	Cooling		Cooling	Heating		Heating	Spring	Fall
	From	To	Day	From	To	Day	Day	Day
1981	30-May-81	15-Oct-81	135	04-Oct-81	21-Apr-82	197		46
1982	07-Jun-82	22-Sep-82	105	23-Oct-82	12-Apr-83	169	31	61
1983	13-Jun-83	20-Sep-83	97	22-Oct-83	24-Apr-84	182	32	44
1984	08-Jun-84	24-Sep-84	106	25-Oct-84	19-Apr-85	174	31	40
1985	29-May-85	26-Sep-85	117	04-Oct-85	05-Apr-86	181	8	63
1986	08-Jun-86	06-Oct-86	118	14-Oct-86	08-Apr-87	174	8	41
1987	19-May-87	29-Sep-87	130	12-Nov-87	24-Apr-88	162	43	14
1988	08-May-88	29-Sep-88	141	12-Nov-88	11-Apr-89	149	43	
AVG. NUMBER OF DAYS			119			174	28	44

THESE INFORMATION WERE GIVEN TO EMC BY FT. SILL. THIS INDICATES WHEN HEATING AND COOLING BEGIN AND END. THE AVERAGE NUMBER OF DAYS ARE USED IN THE PC-CUBE PROGRAM TO CALCULATE ENERGY CONSUMPTION.

THE DESIGN COOLING AND HEATING SET POINTS ARE:
101 DEGREE F (DB) FOR COOLING
12 DEGREE F (DB) FOR HEATING

BASE ON THE AVERAGE TEMPERATURE AT FT. SILL, THE PEAK HEATING AND COOLING OCCUR ON THE FOLLOWING MONTHS

MONTH	HTG	CLG
MAY		
JUN		
JUL		
AUG		
SEP		
OCT		
NOV		
DEC		
JAN		
FEB		
MAR		
APR		

MONTHS WHERE PEAK HEATING/COOLING REQUIRED

AVERAGE TEMP CALC. @ FT. SILL

	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
107								0	2	3		
102					0		0	4	26	22	2	
97					0	0	3	27	78	58	12	
92					1	3	14	67	103	90	37	6
87					4	13	45	100	110	104	62	17
82	2	0	0	1	9	30	79	122	139	128	87	40
77	14	1	0	3	17	55	105	140	154	156	121	50
72	32	4	5	7	31	84	139	132	100	133	140	91
67	48	13	11	17	48	118	140	84	26	40	120	111
62	73	32	25	32	66	126	117	35	4	9	77	127
57	85	56	37	49	81	110	62	9	1	2	40	118
52	112	77	53	66	97	86	29	1			17	86
47	111	107	79	88	103	51	11				3	62
42	108	113	104	109	106	27	2				0	28
37	78	125	112	104	87	13	0					7
32	36	107	112	86	56	5						1
27	13	62	85	62	23	1						1
22	5	32	53	33	8	0						
17	0	9	37	10	4							
12	0	6	16	2	1							
7	0	1	11									
2												

	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
107	0	0	0	0	0	0	0	0	214	321	0	0
102	0	0	0	0	0	0	0	408	2652	2244	204	0
97	0	0	0	0	0	0	291	2619	7566	5626	1164	0
92	0	0	0	0	92	276	1288	6164	9476	8280	3404	552
87	0	0	0	0	348	1131	3915	8700	9570	9048	5394	1479
82	164	0	0	82	738	2460	6478	10004	11398	10496	7134	3280
77	1078	77	0	231	1309	4235	8085	10780	11858	12012	9317	3850
72	2304	288	360	504	2232	6048	10008	9504	7200	9576	10080	6552
67	3216	871	737	1139	3216	7906	9380	5628	1742	2680	8040	7437
62	4526	1984	1550	1984	4092	7812	7254	2170	248	558	4774	7874
57	4845	3192	2109	2793	4617	6270	3534	513	57	114	2280	6726
52	5824	4004	2756	3432	5044	4472	1508	52	0	0	884	4472
47	5217	5029	3713	4136	4841	2397	517	0	0	0	141	2914
42	4536	4746	4368	4578	4452	1134	84	0	0	0	0	1176
37	2886	4625	4144	3848	3219	481	0	0	0	0	0	259
32	1152	3424	3584	2752	1792	160	0	0	0	0	0	32
27	351	1674	2295	1674	621	27	0	0	0	0	0	27
22	110	704	1166	726	176	0	0	0	0	0	0	0
17	0	153	629	170	68	0	0	0	0	0	0	0
12	0	72	192	24	12	0	0	0	0	0	0	0
7	0	7	77	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
AVG	51	41	37	42	50	62	70	78	83	82	74	63
	58	58	58	58	58	58	58	58	58	58	58	58

STATE Station	LOCATION Lat	Long	Elev	WINTER DESIGN DATA HEATING Dry Bulb 99%	97.5%	Pvlg Wind	Mean Speed	DEGREE DAYS Heating	SUMMER DESIGN DATA AIR CONDITIONING Dry Bulb 1%	MCWB	2.5%	MCWB	Mean Daily Range	Pvlg Wind	5%	MCWB	Wet Bulb 1%	2.5%	5%	SUMMER CRITERIA DATA AIR CONDITIONING Dry Bulb ≥ 93°F	≥ 80°F	Wet Bulb ≥ 73°F	≥ 67°F
	° '	° '	feet	°F	°F	dir	knots	annual	°F	°F	°F	°F	°F	dir	°F	°F	°F	°F	°F	hrs	hrs	hrs	hrs
OHIO (CONT)	N	W																					
Lorain Co Rgnl Aprt	41 21	82 11	794	1	6	SW	8	6094	93	73	91	72	24	SW	88	71	76	74	73	38	681	176	997
Mansfield/Lahm MAP	40 49	82 31	1295	0	5	W	8	5818	90	73	87	72	21	SW	85	72	76	74	73	9	431	183	989
Newark	40 01	82 28	880	-1	5	W	8	5655	94	73	92	73	24	SSW	89	72	77	75	74	56	745	282	1301
Portsmouth	38 45	82 55	540	5	10	W	8	4547	95	76	92	74	22	SW	89	73	78	77	75	66	942	470	1671
Ravenna AAP	41 11	81 06	1130	-2	4	SW	9	6262	93	73	90	72	22	SW	87	71	76	74	73	38	563	176	1054
Rickenbacker AFB/Columbus	39 49	82 56	744	-1	3	W	8	5567	90	74	88	73	22	WSW	86	72	77	75	73	11	575	223	1147
Ridgewood AAP	39 15	84 40	670	1	6	W	9	5070	92	73	90	72	23	SW	88	72	77	75	74	24	748	316	1423
Springfield MAP	39 50	83 50	1052	-1	3	W	7	5284	91	74	89	73	22	W	87	72	77	76	74	12	686	297	1293
Toledo/Toledo Express Aprt	41 36	83 48	669	-3	1	WSW	8	6381	90	73	88	73	25	SW	85	71	76	75	73	11	506	197	997
Wright-Patterson AFB/Dayton	39 49	84 03	824	-1	3	W	7	5455	91	74	89	73	22	W	87	72	77	76	74	12	686	297	1293
Youngstown MAP	41 16	80 40	1178	-1	4	SW	10	6426	88	71	86	71	23	SW	84	70	74	73	71	4	371	82	729
Zanesville MAP	39 57	81 54	900	1	7	W	6	5738	93	75	90	74	27	WSW	87	73	78	76	75	28	627	339	1314
OKLAHOMA	N	W																					
Altus AFB	34 39	99 16	1378	11	16	N	10	3346	102	73	100	73	26	S	98	73	77	76	75	422	1684	633	2292
Clinton-Sherman AFB	35 20	99 12	1928	6	12	N	12	3931	100	73	97	72	25	S	95	71	75	74	74	243	1339	283	1821
Fort Sill/Post AAF	34 39	98 24	1187	12	16	N	12	3367	101	74	99	74	25	S	96	74	78	77	76	346	1601	797	2412
McAlester NAD	34 50	95 55	776	14	19	N	10	3255	99	74	96	74	24	S	93	74	77	76	75	181	1505	618	2211
Norman	35 15	97 29	1181	9	13	N	10	3247	99	74	96	74	22	S	94	74	77	76	75	193	1331	618	2211
Oklahoma City AFS	35 24	97 22	1262	9	13	N	10	3588	99	74	96	74	22	S	94	74	77	76	75	193	1331	618	2211
Oklahoma City Aprt	35 24	97 36	1285	9	13	N	14	3695	100	74	97	74	24	SSW	95	73	78	77	76	240	1392	799	2357
Stillwater/Searcy Field	36 10	97 05	984	8	13	N	12	3631	100	74	96	74	25	SSW	93	74	77	76	75	145	1410	618	2211
Tinker AFB/Oklahoma City	35 25	97 23	1291	9	13	N	10	3588	99	74	96	74	22	S	94	74	77	76	75	193	1331	618	2211
Tulsa IAP	36 12	95 54	650	8	13	N	11	3680	101	74	98	75	24	SSW	95	75	79	78	77	270	1543	1089	2478
Vance AFB/Enid	36 21	97 55	1307	9	13	NNE	13	3971	103	74	100	74	26	SSW	97	74	79	77	76	373	1521	836	2234
OREGON	N	W																					
Astoria	46 09	123 53	8	25	29	ESE	7	5295	75	65	71	62	20	NNW	68	61	65	63	62	1	16	0	14
Burns	43 35	119 03	4151	0	6	WNW	6	7212	91	61	89	59	35	NNW	86	58	63	61	60	19	462	0	1
Corvallis MAP	44 30	123 17	246	18	22	N	6	4854	92	67	89	66	33	N	86	65	69	67	66	27	372	4	100
Eugene	44 07	123 13	359	17	22	N	7	4739	92	67	89	66	33	N	86	65	69	67	66	28	393	4	100
Grants Pass	42 26	123 19	925	20	24	N	5	4375	99	69	96	68	38	N	93	67	71	69	68	160	700	9	255
Keno AFS	42 04	121 58	6400	-3	2	N	7	7687	83	57	80	56	28	W	77	55	59	57	56	0	70	0	0
Kingsley Field	42 09	121 44	4092	4	9	N	4	6987	90	61	87	60	37	W	84	59	63	61	60	6	354	0	1
Klamath Falls	42 09	121 44	4092	4	9	N	4	6987	90	61	87	60	37	W	84	59	63	61	60	6	354	0	1

FORT SILL/POST AAF OKLAHOMA

Temperature Range	NOVEMBER Obsn Hour Gp 01 to 08	NOVEMBER Obsn Hour Gp 09 to 16	NOVEMBER Obsn Hour Gp 17 to 24	NOVEMBER Total Obsn	NOVEMBER RCWB	DECEMBER Obsn Hour Gp 01 to 08	DECEMBER Obsn Hour Gp 09 to 16	DECEMBER Obsn Hour Gp 17 to 24	DECEMBER Total Obsn	DECEMBER RCWB	JANUARY Obsn Hour Gp 01 to 08	JANUARY Obsn Hour Gp 09 to 16	JANUARY Obsn Hour Gp 17 to 24	JANUARY Total Obsn	JANUARY RCWB
105/109															
100/104															
95/99															
90/94															
85/89															
80/84		2	0	2	61		0'		0	58		0		0	55
75/79		12	2	14	61		1	0	1	58		0	0	0	57
70/74	1	20	11	32	60		3	1	4	56		4	1	5	54
65/69	5	25	18	48	57		10	3	13	55		7	4	11	54
60/64	12	35	26	73	53	2	20	10	32	52	2	14	9	25	52
55/59	17	35	33	85	50	8	29	19	56	49	5	19	13	37	49
50/54	35	34	43	112	46	11	36	30	77	45	6	26	21	53	45
45/49	41	32	38	111	42	23	38	46	107	41	15	33	31	79	41
40/44	48	24	36	108	38	37	34	42	113	37	30	34	40	104	38
35/39	45	13	20	78	34	54	31	40	125	33	40	33	39	112	33
30/34	23	5	8	36	29	54	25	28	107	30	48	30	34	112	29
25/29	8	2	3	13	25	33	13	16	62	25	41	20	24	85	25
20/24	4	0	1	5	20	16	7	9	32	21	27	11	15	53	20
15/19	0	0	0	0	14	4	2	3	9	15	17	10	10	37	16
10/14	0			0	11	4	1	1	6	11	8	4	4	16	11
5/9						1	0		1	7	6	2	3	11	6
0/4											2	0		2	2
-5/-1											0			0	-1

Temperature Range	FEBRUARY Obsn Hour Gp 01 to 08	FEBRUARY Obsn Hour Gp 09 to 16	FEBRUARY Obsn Hour Gp 17 to 24	FEBRUARY Total Obsn	FEBRUARY RCWB	MARCH Obsn Hour Gp 01 to 08	MARCH Obsn Hour Gp 09 to 16	MARCH Obsn Hour Gp 17 to 24	MARCH Total Obsn	MARCH RCWB	APRIL Obsn Hour Gp 01 to 08	APRIL Obsn Hour Gp 09 to 16	APRIL Obsn Hour Gp 17 to 24	APRIL Total Obsn	APRIL RCWB
105/109															
100/104							0	0	0	69					
95/99							0	0	0	67		0		0	69
90/94							1	0	1	64		2	1	3	65
85/89							3	1	4	62		9	4	13	65
80/84		1	0	1	61		5	4	9	61		20	10	30	64
75/79		2	1	3	56		11	6	17	59	0	33	22	55	62
70/74		5	2	7	56	1	18	12	31	56	7	40	37	84	61
65/69	0	11	6	17	54	4	25	19	48	54	33	42	43	118	59
60/64	1	18	13	32	51	10	29	27	66	52	42	39	45	126	55
55/59	6	24	19	49	48	20	29	32	81	48	50	26	34	110	51
50/54	9	28	29	66	44	27	33	37	97	45	45	17	24	86	46
45/49	23	30	35	88	41	39	29	35	103	41	30	8	13	51	42
40/44	37	33	39	109	37	46	27	33	106	38	20	2	5	27	38
35/39	44	29	31	104	33	46	20	21	87	33	10	1	2	13	34
30/34	41	20	25	86	29	31	11	14	56	29	3	1	1	5	30
25/29	35	14	13	62	25	15	4	4	23	25	1		0	1	26
20/24	18	7	8	33	20	5	2	1	8	20	0			0	23
15/19	6	2	2	10	16	2	1	1	4	15					
10/14	2	0	0	2	11	1	0		1	12					
5/9															
0/4															
-5/-1															

Temperature Range	ANNUAL TOTAL Obsn Hour Gp 01 to 08	ANNUAL TOTAL Obsn Hour Gp 09 to 16	ANNUAL TOTAL Obsn Hour Gp 17 to 24	ANNUAL TOTAL Total Obsn	ANNUAL TOTAL RCWB
105/109		4	1	5	75
100/104		39	15	54	74
95/99		117	61	178	74
90/94	0	201	120	321	73
85/89	10	253	192	455	71
80/84	89	283	265	637	69
75/79	269	261	286	816	67
70/74	378	249	271	898	65
65/69	301	236	239	776	60
60/64	256	229	238	723	55
55/59	234	203	213	650	50
50/54	211	192	221	624	46
45/49	224	177	214	615	42
40/44	240	157	200	597	38
35/39	244	128	154	526	33
30/34	201	92	110	403	29
25/29	134	53	60	247	25
20/24	70	27	34	131	20
15/19	29	15	16	60	16
10/14	15	5	5	25	11
5/9	7	2	3	12	6
0/4	2	0		2	2
-5/-1	0			0	-1

FORT SILL/POST AAF OKLAHOMA

LAT 34 39N LONG 98 24W ELEV 1187 FT

MEAN FREQUENCY OF OCCURRENCE OF DRY BULB TEMPERATURE (DEGREES F) WITH MEAN COINCIDENT WET BULB TEMPERATURE (DEGREES F) FOR EACH DRY BULB TEMPERATURE RANGE

Temperature Range	MAY Obsn Hour Gp 01 to 08	MAY 09 to 16	MAY 17 to 24	MAY Total Obsn	MAY MCWB	JUNE Obsn Hour Gp 01 to 08	JUNE 09 to 16	JUNE 17 to 24	JUNE Total Obsn	JUNE MCWB	JULY Obsn Hour Gp 01 to 08	JULY 09 to 16	JULY 17 to 24	JULY Total Obsn	JULY MCWB
105/109								0	0	76		2	0	2	74
100/104		0	0	0	70		3	1	4	74		18	8	26	74
95/99		2	1	3	69		18	9	27	74		50	28	78	74
90/94		9	5	14	71		42	25	67	74	0	61	42	103	74
85/89		29	16	45	69	1	57	42	100	72	7	50	53	110	73
80/84	0	49	30	79	68	15	51	56	122	71	44	37	58	139	71
75/79	5	52	48	105	66	55	33	52	140	69	99	19	36	154	70
70/74	42	45	52	139	64	80	21	31	132	67	75	7	18	100	68
65/69	64	32	44	140	61	57	11	16	84	64	20	3	3	26	64
60/64	66	18	33	117	58	24	4	7	35	60	3	0	1	4	59
55/59	39	9	14	62	53	7	1	1	9	55	1			1	57
50/54	20	3	6	29	48	1		0	1	49					
45/49	9	1	1	11	44										
40/44	2			2	40										
35/39	0			0	36										
30/34															
25/29															

Temperature Range	AUGUST Obsn Hour Gp 01 to 08	AUGUST 09 to 16	AUGUST 17 to 24	AUGUST Total Obsn	AUGUST MCWB	SEPTEMBER Obsn Hour Gp 01 to 08	SEPTEMBER 09 to 16	SEPTEMBER 17 to 24	SEPTEMBER Total Obsn	SEPTEMBER MCWB	OCTOBER Obsn Hour Gp 01 to 08	OCTOBER 09 to 16	OCTOBER 17 to 24	OCTOBER Total Obsn	OCTOBER MCWB
105/109		2	1	3	76										
100/104		16	6	22	74		2	0	2	75					
95/99		38	20	58	74		9	3	12	73					
90/94		55	35	90	73		26	11	37	73		5	1	6	65
85/89	2	53	49	104	72	0	39	23	62	71		13	4	17	67
80/84	27	43	58	128	71	3	46	38	87	69		29	11	40	66
75/79	81	25	50	156	69	29	43	49	121	67	0	30	20	50	64
70/74	97	12	24	133	67	63	33	44	140	66	12	41	38	91	62
65/69	32	3	5	40	63	60	23	37	120	62	26	44	41	111	59
60/64	7	1	1	9	58	43	12	22	77	58	44	39	44	127	55
55/59	2	0	0	2	55	27	5	8	40	53	52	26	40	118	51
50/54						11	2	4	17	49	46	13	27	86	47
45/49						3		0	3	45	41	6	15	62	43
40/44						0			0	42	20	3	5	28	39
35/39											5	1	1	7	35
30/34											1	0	0	1	31
25/29											1			1	27

OKLAHOMA CITY, OKLAHOMA 35-24N 97-36W 1285 FT. ELEV. APRIL

TEMP BIN	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	HORIZ. SOLAR (BTUH/SQ.FT.)
DRY-BULB TEMPERATURES:			HOURS OF OCCURRENCE (MCWB)					
90 / 94	0 (0)	0 (0)	0 (0)	2 (71)	1 (71)	0 (0)	3 (71)	123
85 / 89	0 (0)	0 (0)	0 (0)	16 (70)	4 (70)	0 (0)	20 (70)	196
80 / 84	0 (0)	0 (0)	7 (69)	15 (63)	11 (67)	0 (0)	33 (66)	199
75 / 79	0 (0)	0 (0)	14 (65)	17 (63)	20 (66)	8 (68)	59 (65)	142
70 / 74	19 (66)	12 (66)	20 (63)	13 (59)	18 (62)	26 (66)	108 (64)	134
65 / 69	11 (63)	18 (64)	11 (56)	9 (51)	9 (53)	11 (58)	69 (59)	142
60 / 64	15 (56)	7 (59)	14 (49)	21 (47)	15 (48)	11 (53)	83 (51)	140
55 / 59	11 (50)	6 (51)	17 (46)	9 (45)	18 (46)	7 (48)	68 (47)	168
50 / 54	14 (44)	22 (46)	10 (42)	9 (43)	9 (43)	21 (45)	85 (44)	130
45 / 49	14 (41)	13 (42)	17 (42)	9 (41)	13 (41)	15 (41)	81 (41)	103
40 / 44	19 (37)	23 (38)	10 (38)	0 (0)	2 (39)	16 (39)	70 (38)	73
35 / 39	14 (35)	16 (35)	0 (0)	0 (0)	0 (0)	5 (36)	35 (35)	39
30 / 34	3 (32)	3 (32)	0 (0)	0 (0)	0 (0)	0 (0)	6 (32)	44
WET-BULB TEMPERATURES:			HOURS OF OCCURRENCE (MCDB)					
72 / 73	0 (0)	0 (0)	0 (0)	3 (86)	1 (85)	0 (0)	4 (86)	
70 / 71	0 (0)	0 (0)	4 (81)	12 (87)	7 (82)	0 (0)	23 (84)	
68 / 69	0 (0)	1 (74)	7 (79)	13 (81)	13 (80)	7 (75)	41 (79)	
66 / 67	13 (71)	11 (70)	13 (75)	5 (76)	13 (75)	19 (73)	74 (73)	
64 / 65	14 (69)	11 (69)	9 (72)	3 (75)	2 (74)	9 (71)	48 (71)	
62 / 63	2 (67)	7 (67)	3 (70)	8 (80)	5 (79)	0 (0)	25 (74)	
60 / 61	3 (63)	3 (65)	1 (76)	1 (72)	3 (72)	1 (70)	12 (68)	
58 / 59	3 (63)	3 (64)	2 (70)	6 (74)	5 (75)	6 (65)	25 (69)	
56 / 57	5 (64)	0 (0)	6 (69)	5 (77)	1 (66)	4 (63)	21 (68)	
54 / 55	4 (60)	2 (56)	4 (67)	7 (75)	7 (71)	4 (63)	28 (67)	
52 / 53	1 (59)	0 (0)	8 (67)	4 (67)	8 (64)	3 (64)	24 (65)	
50 / 51	5 (57)	4 (57)	4 (61)	11 (61)	6 (58)	3 (61)	33 (59)	
48 / 49	5 (58)	5 (53)	8 (58)	7 (58)	10 (60)	4 (58)	39 (58)	
46 / 47	6 (52)	7 (53)	9 (53)	7 (62)	9 (56)	5 (53)	43 (55)	
44 / 45	4 (51)	12 (52)	8 (56)	13 (59)	11 (57)	15 (52)	63 (55)	
42 / 43	7 (47)	8 (48)	9 (53)	5 (52)	7 (50)	11 (50)	47 (50)	
40 / 41	11 (47)	7 (45)	11 (48)	2 (47)	3 (46)	11 (46)	45 (47)	
38 / 39	13 (42)	7 (42)	8 (46)	8 (51)	8 (48)	7 (43)	51 (45)	
36 / 37	11 (39)	18 (40)	6 (43)	0 (0)	1 (47)	7 (41)	43 (41)	
34 / 35	8 (38)	8 (37)	0 (0)	0 (0)	0 (0)	4 (38)	20 (38)	
32 / 33	4 (36)	6 (35)	0 (0)	0 (0)	0 (0)	0 (0)	10 (35)	

AVERAGE VALUES:	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	
DRY-BULB AVERAGES	53.5	52.3	61.6	69.4	65.8	58	60.1	DEG.F
WET-BULB AVERAGES	48.6	47.8	52.2	55.6	54.6	51.4	51.7	DEG.F
DAILY HORIZONTAL SOLAR		120	727	751	132		1730	BTU/SQ.FT.
WIND SPEED AVERAGES	14.9	16.3	18.1	17.7	15.6	14.3	16.1	MPH

OKLAHOMA CITY, OKLAHOMA 35-24N 97-36W 1285 FT. ELEV. MAY

	TIME GROUP							HORIZ. SOLAR
TEMP BIN	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	(BTUH/SQ.FT.)
DRY-BULB TEMPERATURES:			HOURS OF OCCURRENCE (MCWB)					
90 / 94	0 (0)	0 (0)	0 (0)	4 (68)	1 (64)	0 (0)	5 (67)	196
85 / 89	0 (0)	0 (0)	2 (72)	18 (70)	6 (70)	0 (0)	26 (70)	209
80 / 84	0 (0)	0 (0)	17 (68)	40 (68)	28 (68)	0 (0)	85 (68)	157
75 / 79	1 (70)	3 (71)	27 (66)	25 (63)	34 (66)	12 (67)	102 (66)	150
70 / 74	15 (64)	14 (65)	30 (62)	14 (60)	26 (63)	27 (64)	126 (63)	154
65 / 69	37 (62)	29 (62)	20 (57)	12 (54)	14 (55)	35 (62)	147 (60)	133
60 / 64	34 (58)	28 (56)	17 (54)	8 (54)	7 (53)	24 (57)	118 (56)	106
55 / 59	16 (53)	35 (53)	9 (53)	3 (56)	7 (52)	18 (52)	88 (53)	60
50 / 54	12 (48)	7 (47)	2 (43)	0 (0)	1 (46)	5 (47)	27 (47)	96
45 / 49	5 (45)	5 (43)	0 (0)	0 (0)	0 (0)	3 (44)	13 (44)	56
40 / 44	4 (40)	2 (40)	0 (0)	0 (0)	0 (0)	0 (0)	6 (40)	0
35 / 39	0 (0)	1 (37)	0 (0)	0 (0)	0 (0)	0 (0)	1 (37)	8
WET-BULB TEMPERATURES:			HOURS OF OCCURRENCE (MCDB)					
74 / 75	0 (0)	0 (0)	0 (0)	1 (87)	0 (0)	0 (0)	1 (87)	
72 / 73	0 (0)	0 (0)	5 (81)	21 (84)	7 (85)	0 (0)	33 (84)	
70 / 71	2 (74)	4 (75)	7 (80)	6 (82)	15 (80)	0 (0)	34 (79)	
68 / 69	2 (73)	1 (72)	16 (79)	22 (81)	21 (78)	12 (75)	74 (78)	
66 / 67	2 (71)	4 (70)	15 (75)	10 (81)	17 (77)	7 (72)	55 (76)	
64 / 65	8 (69)	11 (69)	13 (73)	10 (81)	8 (78)	19 (71)	69 (73)	
62 / 63	27 (66)	19 (67)	7 (75)	13 (79)	12 (78)	20 (68)	98 (71)	
60 / 61	16 (65)	9 (65)	9 (73)	4 (79)	6 (73)	18 (67)	62 (69)	
58 / 59	11 (62)	11 (63)	10 (70)	5 (65)	2 (73)	8 (66)	47 (65)	
56 / 57	14 (62)	14 (60)	15 (62)	10 (70)	10 (70)	3 (64)	66 (64)	
54 / 55	8 (60)	15 (59)	7 (64)	13 (69)	12 (64)	11 (59)	66 (63)	
52 / 53	8 (60)	7 (58)	8 (66)	6 (66)	8 (66)	8 (58)	45 (62)	
50 / 51	5 (54)	6 (57)	8 (63)	2 (64)	2 (60)	4 (59)	27 (59)	
48 / 49	6 (54)	11 (57)	1 (58)	1 (60)	2 (60)	8 (56)	29 (56)	
46 / 47	7 (51)	3 (52)	1 (57)	0 (0)	2 (54)	2 (52)	15 (52)	
44 / 45	3 (48)	3 (48)	0 (0)	0 (0)	0 (0)	2 (49)	8 (48)	
42 / 43	1 (45)	2 (47)	2 (52)	0 (0)	0 (0)	2 (46)	7 (48)	
40 / 41	3 (43)	2 (45)	0 (0)	0 (0)	0 (0)	0 (0)	5 (43)	
38 / 39	1 (40)	1 (40)	0 (0)	0 (0)	0 (0)	0 (0)	2 (40)	
36 / 37	0 (0)	1 (39)	0 (0)	0 (0)	0 (0)	0 (0)	1 (39)	

AVERAGE VALUES:

	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	
DRY-BULB AVERAGES	61.6	61.5	71.1	77.5	74.3	65.4	68.6	DEG.F
WET-BULB AVERAGES	57.1	56.6	61.2	63.9	63	59.4	60.2	DEG.F
DAILY HORIZONTAL SOLAR		172	770	814	174		1930	BTU/SQ.FT.
WIND SPEED AVERAGES	13.8	14.3	16.1	16.9	15.4	13.5	15	MPH

WIND FREQUENCIES: HOURS OF OCCURRENCE (PREVAILING DIRECTION)

	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL
< 5.5 MPH	0 (*)	3 (ENE)	3 (S)	4 (E)	2 (SSW)	0 (*)	12 (S)
5.5-14.4 MPH	78 (SSE)	55 (SSE)	40 (SSE)	36 (SSE)	51 (SSE)	80 (SE)	340 (SSE)

OKLAHOMA CITY, OKLAHOMA 35-24N 97-36W 1285 FT. ELEV. JUNE

TEMP BIN	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	HORIZ. SOLAR (BTUH/SQ.FT.)
DRY-BULB TEMPERATURES:			HOURS OF OCCURRENCE (MCWB)					
95 / 99	0 (0)	0 (0)	0 (0)	2 (77)	0 (0)	0 (0)	2 (77)	219
90 / 94	0 (0)	0 (0)	6 (76)	40 (75)	16 (75)	0 (0)	62 (75)	209
85 / 89	0 (0)	0 (0)	30 (74)	34 (74)	32 (73)	4 (74)	100 (74)	201
80 / 84	6 (72)	5 (72)	32 (73)	14 (68)	31 (72)	15 (71)	103 (72)	175
75 / 79	19 (70)	20 (71)	21 (69)	10 (67)	15 (68)	40 (71)	125 (70)	152
70 / 74	55 (69)	45 (69)	11 (65)	9 (65)	13 (67)	33 (69)	166 (68)	101
65 / 69	20 (66)	29 (65)	13 (63)	7 (65)	9 (64)	18 (64)	96 (65)	74
60 / 64	10 (59)	12 (61)	3 (60)	2 (53)	4 (56)	8 (59)	39 (59)	62
55 / 59	8 (56)	6 (55)	3 (55)	2 (53)	0 (0)	2 (53)	21 (55)	63
50 / 54	2 (51)	3 (50)	1 (52)	0 (0)	0 (0)	0 (0)	6 (51)	47
WET-BULB TEMPERATURES:			HOURS OF OCCURRENCE (MCDB)					
78 / 79	0 (0)	0 (0)	3 (91)	4 (94)	4 (93)	0 (0)	11 (93)	
76 / 77	0 (0)	0 (0)	1 (86)	12 (93)	6 (91)	0 (0)	19 (92)	
74 / 75	0 (0)	1 (82)	26 (86)	34 (88)	26 (87)	4 (85)	91 (87)	
72 / 73	13 (77)	8 (78)	41 (84)	28 (88)	27 (84)	28 (78)	145 (83)	
70 / 71	32 (74)	32 (74)	12 (78)	9 (81)	20 (81)	28 (76)	133 (76)	
68 / 69	26 (71)	23 (72)	7 (70)	6 (76)	11 (79)	21 (73)	94 (73)	
66 / 67	20 (71)	22 (69)	4 (73)	9 (76)	10 (73)	15 (71)	80 (72)	
64 / 65	5 (67)	8 (67)	5 (71)	4 (71)	2 (68)	4 (72)	28 (69)	
62 / 63	4 (65)	8 (64)	9 (68)	6 (75)	6 (72)	8 (66)	41 (68)	
60 / 61	4 (62)	6 (63)	4 (75)	3 (73)	4 (72)	3 (63)	24 (68)	
58 / 59	6 (61)	3 (62)	1 (58)	1 (71)	0 (0)	4 (65)	15 (62)	
56 / 57	4 (59)	3 (58)	2 (69)	0 (0)	2 (64)	1 (64)	12 (62)	
54 / 55	3 (58)	3 (58)	3 (62)	0 (0)	2 (63)	2 (62)	13 (60)	
52 / 53	1 (55)	0 (0)	2 (55)	4 (59)	0 (0)	2 (58)	9 (57)	
50 / 51	2 (53)	2 (53)	0 (0)	0 (0)	0 (0)	0 (0)	4 (53)	
48 / 49	0 (0)	1 (50)	0 (0)	0 (0)	0 (0)	0 (0)	1 (50)	

AVERAGE VALUES:	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	
DRY-BULB AVERAGES	70.1	69.8	79.1	84.1	81.5	73.6	76.4	DEG.F
WET-BULB AVERAGES	66.8	66.6	69.9	71	70.5	68.2	68.8	DEG.F
DAILY HORIZONTAL SOLAR		197	868	869	216		2149	BTU/SQ.FT.
WIND SPEED AVERAGES	11.3	12.2	15.7	15.4	14	12.2	13.5	MPH

WIND FREQUENCIES: HOURS OF OCCURRENCE (PREVAILING DIRECTION)	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL
< 5.5 MPH	15 (S)	9 (NNW)	2 (NNE)	5 (NNW)	3 (NE)	4 (NE)	38 (N)
5.5-14.4 MPH	77 (SSE)	72 (SSE)	51 (SSW)	44 (SSE)	59 (SSE)	82 (SSE)	385 (SSE)
14.5-21.0 MPH	27 (SSE)	33 (S)	46 (SSW)	53 (S)	53 (SSE)	34 (SSE)	246 (SSE)
>21.0 MPH	1 (NNW)	6 (S)	21 (S)	18 (S)	5 (SSE)	0 (*)	51 (S)

DEGREE HOURS (HEATING/COOLING)

TEMP BASE	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL

OKLAHOMA CITY, OKLAHOMA 35-24N 97-36W 1285 FT. ELEV. JULY

TEMP BIN	TIME GROUP 1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	HORIZ. SOLAR (BTUH/SQ.FT.)
DRY-BULB TEMPERATURES:	HOURS OF OCCURRENCE (MCWB)							
100 / 104	0 (0)	0 (0)	0 (0)	2 (77)	0 (0)	0 (0)	2 (77)	208
95 / 99	0 (0)	0 (0)	2 (76)	42 (77)	21 (76)	0 (0)	65 (77)	203
90 / 94	0 (0)	0 (0)	32 (76)	35 (77)	31 (76)	0 (0)	98 (76)	196
85 / 89	2 (73)	0 (0)	38 (75)	23 (75)	26 (75)	15 (74)	104 (75)	201
80 / 84	10 (72)	23 (73)	29 (74)	16 (74)	32 (74)	39 (73)	149 (74)	131
75 / 79	53 (72)	40 (72)	14 (72)	6 (74)	11 (73)	40 (73)	164 (72)	83
70 / 74	50 (71)	51 (70)	9 (71)	0 (0)	3 (72)	28 (71)	141 (70)	38
65 / 69	9 (67)	10 (67)	0 (0)	0 (0)	0 (0)	2 (68)	21 (67)	23
WET-BULB TEMPERATURES:	HOURS OF OCCURRENCE (MCDB)							
80 / 81	0 (0)	0 (0)	0 (0)	3 (90)	0 (0)	0 (0)	3 (90)	
78 / 79	0 (0)	0 (0)	6 (91)	19 (94)	6 (94)	1 (87)	32 (93)	
76 / 77	0 (0)	1 (81)	37 (89)	55 (94)	45 (90)	8 (83)	146 (91)	
74 / 75	11 (78)	12 (80)	44 (86)	34 (87)	48 (88)	31 (81)	180 (85)	
72 / 73	35 (76)	39 (78)	27 (79)	13 (83)	21 (82)	52 (78)	187 (79)	
70 / 71	46 (75)	43 (74)	9 (76)	0 (0)	3 (80)	23 (77)	124 (75)	
68 / 69	24 (73)	20 (72)	1 (74)	0 (0)	1 (76)	8 (72)	54 (73)	
66 / 67	8 (68)	8 (69)	0 (0)	0 (0)	0 (0)	1 (69)	17 (69)	
64 / 65	0 (0)	1 (66)	0 (0)	0 (0)	0 (0)	0 (0)	1 (66)	

AVERAGE VALUES:

	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	
DRY-BULB AVERAGES	74.9	75.1	84.8	90.9	87.5	78.6	82	DEG.F
WET-BULB AVERAGES	70.8	70.9	74.5	76	74.9	72.6	73.3	DEG.F
DAILY HORIZONTAL SOLAR		185	870	882	185		2124	BTU/SQ.FT.
WIND SPEED AVERAGES	9.600001	10.3	13.6	13.2	11.9	10.9	11.6	MPH

WIND FREQUENCIES: HOURS OF OCCURRENCE (PREVAILING DIRECTION)

	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL
< 5.5 MPH	10 (S)	11 (N)	3 (ESE)	5 (NE)	5 (SW)	3 (SSE)	37 (N)
5.5-14.4 MPH	106 (S)	94 (S)	74 (SSW)	64 (SSE)	81 (S)	102 (SSE)	521 (SSE)
14.5-21.0 MPH	7 (SSE)	16 (SSW)	40 (SSW)	52 (SSW)	38 (S)	19 (SSE)	172 (SSW)
>21.0 MPH	1 (N)	3 (SSW)	7 (SSW)	3 (SSW)	0 (*)	0 (*)	14 (SSW)

DEGREE HOURS (HEATING/COOLING) TIME GROUP

TEMP BASE	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL
75	189 / 179	203 / 221	19 / 1231	0 / 1977	3 / 1553	64 / 516	478 / 5677
70	17 / 627	20 / 658	0 / 1832	0 / 2597	0 / 2170	2 / 1074	39 / 8958
65	0 / 1230	0 / 1258	0 / 2452	0 / 3217	0 / 2790	0 / 1692	0 / 12639
60	0 / 1850	0 / 1878	0 / 3072	0 / 3837	0 / 3410	0 / 2312	0 / 16359
57	0 / 2222	0 / 2250	0 / 3444	0 / 4209	0 / 3782	0 / 2684	0 / 18591
55	0 / 2470	0 / 2498	0 / 3692	0 / 4457	0 / 4030	0 / 2932	0 / 20079
50	0 / 3090	0 / 3118	0 / 4312	0 / 5077	0 / 4650	0 / 3552	0 / 23799
45	0 / 3710	0 / 3738	0 / 4932	0 / 5697	0 / 5270	0 / 4172	0 / 27519
40	0 / 4330	0 / 4358	0 / 5552	0 / 6317	0 / 5890	0 / 4792	0 / 31239

OKLAHOMA CITY, OKLAHOMA 35-24N 97-36W 1285 FT. ELEV. AUGUST

TEMP BIN	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	HORIZ. SOLAR (BTUH/SQ.FT.)
				TIME GROUP				
DRY-BULB TEMPERATURES:			HOURS OF OCCURRENCE (MCWB)					
95 / 99	0 (0)	0 (0)	3 (73)	25 (74)	8 (74)	0 (0)	36 (74)	178
90 / 94	0 (0)	0 (0)	16 (74)	54 (73)	32 (73)	0 (0)	102 (73)	179
85 / 89	0 (0)	0 (0)	35 (72)	24 (70)	37 (71)	5 (74)	101 (71)	195
80 / 84	4 (73)	5 (72)	37 (71)	13 (70)	30 (70)	37 (71)	126 (71)	187
75 / 79	40 (70)	21 (70)	19 (69)	6 (71)	12 (69)	41 (69)	139 (69)	137
70 / 74	45 (67)	61 (68)	13 (69)	2 (70)	5 (68)	29 (66)	155 (67)	76
65 / 69	30 (63)	25 (64)	1 (68)	0 (0)	0 (0)	12 (64)	68 (64)	53
60 / 64	5 (61)	12 (61)	0 (0)	0 (0)	0 (0)	0 (0)	17 (61)	32
WET-BULB TEMPERATURES:			HOURS OF OCCURRENCE (MCDB)					
78 / 79	0 (0)	0 (0)	0 (0)	2 (95)	0 (0)	0 (0)	2 (95)	
76 / 77	0 (0)	0 (0)	4 (88)	14 (91)	13 (90)	0 (0)	31 (90)	
74 / 75	1 (84)	1 (81)	26 (86)	22 (94)	18 (89)	13 (83)	81 (88)	
72 / 73	18 (76)	13 (76)	32 (87)	37 (92)	20 (90)	15 (81)	135 (86)	
70 / 71	17 (76)	22 (75)	25 (81)	24 (87)	31 (88)	18 (79)	137 (81)	
68 / 69	17 (75)	17 (74)	22 (79)	18 (86)	28 (83)	22 (77)	124 (79)	
66 / 67	18 (73)	29 (71)	11 (78)	5 (85)	9 (80)	31 (74)	103 (74)	
64 / 65	29 (70)	22 (69)	3 (79)	2 (85)	5 (82)	21 (72)	82 (72)	
62 / 63	15 (67)	11 (66)	1 (73)	0 (0)	0 (0)	3 (69)	30 (67)	
60 / 61	8 (65)	6 (64)	0 (0)	0 (0)	0 (0)	1 (68)	15 (65)	
58 / 59	1 (64)	3 (61)	0 (0)	0 (0)	0 (0)	0 (0)	4 (62)	
AVERAGE VALUES:								
DRY-BULB AVERAGES	72.2	71.4	83	90	86.4	76.6	79.9	DEG.F
WET-BULB AVERAGES	66.9	67	71	72	71	68.5	69.4	DEG.F
DAILY HORIZONTAL SOLAR		136	838	832	151		1957	BTU/SQ.FT.
WIND SPEED AVERAGES	10	10.2	12.7	12.8	12.7	10.3	11.4	MPH
WIND FREQUENCIES:		HOURS OF OCCURRENCE (PREVAILING DIRECTION)						
< 5.5 MPH	9 (S)	6 (S)	3 (S)	10 (S)	3 (ENE)	10 (S)	41 (S)	
5.5-14.4 MPH	102 (SSE)	104 (SSE)	75 (S)	65 (SSE)	80 (SE)	102 (SSE)	528 (SSE)	
14.5-21.0 MPH	13 (SSE)	14 (SSE)	46 (S)	48 (SSE)	39 (SSE)	12 (SSE)	172 (SSE)	
>21.0 MPH	0 (*)	0 (*)	0 (*)	1 (SSE)	2 (SSE)	0 (*)	3 (SSE)	

DEGREE HOURS (HEATING/COOLING)

TEMP BASE	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL
				TIME GROUP			
75	421 / 78	511 / 63	41 / 1031	5 / 1866	13 / 1423	170 / 373	1161 / 4834
70	124 / 401	147 / 319	1 / 1611	0 / 2481	0 / 2030	25 / 848	297 / 7690
65	5 / 902	28 / 820	0 / 2230	0 / 3101	0 / 2650	0 / 1443	33 / 11146
60	0 / 1517	0 / 1412	0 / 2850	0 / 3721	0 / 3270	0 / 2063	0 / 14833
57	0 / 1889	0 / 1784	0 / 3222	0 / 4093	0 / 3642	0 / 2435	0 / 17065
55	0 / 2137	0 / 2032	0 / 3470	0 / 4341	0 / 3890	0 / 2683	0 / 18553
50	0 / 2757	0 / 2652	0 / 4090	0 / 4961	0 / 4510	0 / 3303	0 / 22273

OKLAHOMA CITY, OKLAHOMA 35-24N 97-36W 1285 FT. ELEV. SEPTEMBER

TEMP BIN	TIME GROUP 1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	HORIZ. SOLAR (BTUH/SQ.FT.)
DRY-BULB TEMPERATURES:			HOURS OF OCCURRENCE (MCWB)					
95 / 99	0 (0)	0 (0)	0 (0)	1 (74)	0 (0)	0 (0)	1 (74)	163
90 / 94	0 (0)	0 (0)	1 (73)	18 (74)	7 (72)	0 (0)	26 (73)	168
85 / 89	0 (0)	0 (0)	11 (74)	20 (73)	13 (72)	0 (0)	44 (73)	177
80 / 84	0 (0)	0 (0)	22 (73)	28 (72)	25 (72)	5 (69)	80 (72)	167
75 / 79	8 (70)	9 (72)	19 (71)	21 (69)	28 (70)	28 (71)	113 (70)	143
70 / 74	43 (69)	36 (70)	35 (68)	22 (63)	25 (66)	30 (69)	191 (68)	118
65 / 69	38 (66)	41 (67)	18 (63)	5 (59)	11 (62)	36 (66)	149 (65)	70
60 / 64	15 (62)	15 (60)	5 (57)	1 (59)	7 (56)	6 (58)	49 (60)	78
55 / 59	5 (53)	6 (54)	5 (56)	0 (0)	0 (0)	10 (53)	26 (54)	58
50 / 54	9 (51)	10 (51)	4 (46)	4 (47)	4 (47)	5 (48)	36 (49)	48
45 / 49	2 (45)	3 (46)	0 (0)	0 (0)	0 (0)	0 (0)	5 (46)	12
WET-BULB TEMPERATURES:			HOURS OF OCCURRENCE (MCDB)					
76 / 77	0 (0)	0 (0)	2 (86)	6 (90)	2 (86)	0 (0)	10 (88)	
74 / 75	0 (0)	1 (74)	18 (83)	15 (88)	6 (84)	2 (78)	42 (85)	
72 / 73	7 (75)	8 (74)	26 (81)	41 (85)	26 (84)	13 (76)	121 (82)	
70 / 71	18 (73)	19 (73)	21 (74)	18 (77)	23 (81)	22 (75)	121 (76)	
68 / 69	30 (71)	34 (69)	16 (71)	12 (75)	26 (75)	21 (72)	139 (72)	
66 / 67	21 (69)	18 (68)	10 (70)	4 (78)	11 (74)	26 (70)	90 (70)	
64 / 65	17 (66)	8 (65)	4 (70)	2 (76)	3 (70)	10 (66)	44 (67)	
62 / 63	6 (64)	6 (63)	1 (66)	3 (74)	4 (69)	3 (67)	23 (66)	
60 / 61	5 (64)	3 (61)	2 (62)	3 (69)	3 (67)	4 (66)	20 (65)	
58 / 59	0 (0)	1 (62)	0 (0)	4 (68)	3 (66)	1 (61)	9 (66)	
56 / 57	0 (0)	1 (59)	7 (64)	0 (0)	1 (62)	2 (59)	11 (62)	
54 / 55	1 (55)	4 (59)	5 (61)	8 (72)	6 (68)	5 (58)	29 (64)	
52 / 53	11 (55)	6 (57)	4 (65)	0 (0)	1 (64)	4 (58)	26 (58)	
50 / 51	0 (0)	6 (52)	0 (0)	0 (0)	1 (60)	1 (59)	8 (54)	
48 / 49	0 (0)	2 (51)	0 (0)	1 (54)	0 (0)	3 (56)	6 (54)	
46 / 47	2 (51)	2 (49)	3 (51)	3 (52)	4 (53)	2 (53)	16 (51)	
44 / 45	2 (49)	1 (47)	1 (50)	0 (0)	0 (0)	1 (50)	5 (49)	

AVERAGE VALUES:

	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	
DRY-BULB AVERAGES	67.2	66.5	73.8	79.9	76.4	69.6	72.2	DEG.F
WET-BULB AVERAGES	65.1	64.9	67.8	68.9	67.4	65.6	66.6	DEG.F
DAILY HORIZONTAL SOLAR		66	652	729	98		1545	BTU/SQ.FT.
WIND SPEED AVERAGES	11.1	11.4	14.7	14.9	13.4	12.3	13	MPH

WIND FREQUENCIES: HOURS OF OCCURRENCE (PREVAILING DIRECTION)

	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL
< 5.5 MPH	5 (N)	10 (ESE)	3 (N)	4 (NNE)	0 (*)	0 (*)	22 (N)
5.5-14.4 MPH	89 (SSE)	77 (SSE)	64 (SSE)	48 (SSE)	71 (SSE)	89 (SSE)	438 (SSE)
14.5-21.0 MPH	26 (SSE)	30 (SSE)	39 (SSW)	60 (SSE)	46 (SSE)	31 (SSE)	232 (SSE)
>21.0 MPH	0 (*)	3 (N)	14 (SSW)	8 (SSW)	3 (NNW)	0 (*)	28 (SSW)

OKLAHOMA CITY, OKLAHOMA 35-24N 97-36W 1285 FT. ELEV. OCTOBER

TEMP BIN	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	HORIZ. SOLAR (BTUH/SQ.FT.)
DRY-BULB TEMPERATURES:			HOURS OF OCCURRENCE (MCWB)					
85 / 89	0 (0)	0 (0)	0 (0)	10 (72)	2 (72)	0 (0)	12 (72)	146
80 / 84	0 (0)	0 (0)	4 (70)	21 (65)	8 (67)	0 (0)	33 (66)	148
75 / 79	0 (0)	0 (0)	15 (66)	24 (64)	19 (65)	2 (70)	60 (65)	149
70 / 74	2 (69)	2 (69)	17 (64)	20 (56)	13 (61)	13 (68)	67 (62)	140
65 / 69	16 (65)	9 (66)	23 (57)	12 (54)	27 (56)	17 (58)	104 (59)	113
60 / 64	25 (55)	23 (57)	20 (54)	15 (50)	16 (52)	29 (55)	128 (54)	101
55 / 59	27 (53)	27 (53)	17 (50)	15 (47)	17 (48)	13 (52)	116 (51)	87
50 / 54	16 (49)	23 (49)	17 (45)	7 (45)	17 (45)	23 (48)	103 (47)	80
45 / 49	24 (43)	22 (43)	10 (43)	0 (0)	5 (43)	23 (43)	84 (43)	47
40 / 44	9 (40)	9 (40)	1 (40)	0 (0)	0 (0)	4 (39)	23 (40)	78
35 / 39	5 (36)	9 (37)	0 (0)	0 (0)	0 (0)	0 (0)	14 (37)	29
WET-BULB TEMPERATURES:			HOURS OF OCCURRENCE (MCDB)					
72 / 73	0 (0)	0 (0)	2 (82)	8 (86)	2 (86)	0 (0)	12 (85)	
70 / 71	0 (0)	0 (0)	10 (76)	4 (85)	5 (80)	8 (74)	27 (77)	
68 / 69	5 (70)	4 (70)	1 (74)	5 (78)	4 (79)	3 (70)	22 (74)	
66 / 67	6 (68)	4 (67)	2 (71)	7 (80)	6 (78)	2 (72)	27 (74)	
64 / 65	1 (67)	4 (65)	10 (74)	12 (80)	3 (77)	3 (71)	33 (75)	
62 / 63	4 (67)	2 (62)	11 (71)	12 (79)	10 (77)	3 (63)	42 (73)	
60 / 61	8 (63)	7 (62)	8 (67)	7 (75)	15 (70)	6 (66)	51 (67)	
58 / 59	0 (0)	3 (64)	8 (68)	7 (77)	7 (67)	4 (66)	29 (69)	
56 / 57	13 (59)	7 (58)	6 (67)	6 (70)	7 (68)	19 (63)	58 (63)	
54 / 55	15 (59)	16 (57)	11 (62)	7 (66)	6 (65)	9 (61)	64 (61)	
52 / 53	6 (58)	11 (55)	3 (63)	15 (68)	11 (64)	4 (53)	50 (62)	
50 / 51	15 (56)	10 (56)	8 (64)	5 (64)	10 (64)	14 (59)	62 (59)	
48 / 49	8 (56)	8 (53)	13 (60)	9 (60)	10 (58)	9 (56)	57 (57)	
46 / 47	4 (53)	4 (56)	6 (54)	9 (57)	8 (56)	5 (53)	36 (55)	
44 / 45	4 (49)	4 (49)	13 (51)	11 (54)	16 (52)	14 (50)	62 (51)	
42 / 43	20 (47)	24 (46)	11 (50)	0 (0)	2 (51)	12 (48)	69 (47)	
40 / 41	7 (44)	4 (44)	1 (42)	0 (0)	2 (48)	6 (45)	20 (45)	
38 / 39	3 (41)	5 (41)	0 (0)	0 (0)	0 (0)	1 (44)	9 (41)	
36 / 37	5 (38)	5 (38)	0 (0)	0 (0)	0 (0)	2 (41)	12 (38)	
34 / 35	0 (0)	2 (36)	0 (0)	0 (0)	0 (0)	0 (0)	2 (36)	

AVERAGE VALUES:	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	TOTAL	
DRY-BULB AVERAGES	55.1	53.5	63.5	71.2	65.5	58.2	61.2	DEG.F
WET-BULB AVERAGES	51.2	50.4	55.1	57.5	55.2	52.5	53.7	DEG.F
DAILY HORIZONTAL SOLAR		38	555	582	43		1218	BTU/SQ.FT.
WIND SPEED AVERAGES	11	10.6	13.4	14	11.4	11.8	12	MPH

WIND FREQUENCIES:		HOURS OF OCCURRENCE (PREVAILING DIRECTION)					
< 5.5 MPH	0 (*)	3 (N)	6 (N)	7 (WNW)	5 (SSE)	0 (*)	21 (WNW)
5.5-14.4 MPH	111 (S)	107 (S)	73 (S)	65 (S)	94 (SSE)	100 (S)	550 (S)
14.5-21.0 MPH	11 (S)	11 (S)	35 (SSW)	40 (S)	23 (SSE)	22 (SSE)	142 (S)

DOMESTIC HOT WATER LOAD CALCULATIONS

JOB FT SILL CENTRAL PLANT 3002-000

SHEET NO. ______ OF ______

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

CALCULATED BY KC DATE 3-14-91

CHECKED BY ______ DATE ______

SCALE DOMESTIC HW LOAD CALC.

BLDG 730

THERE ARE 4 BLDG. (CLASSROOM) CONNECTED TO HEATING PLANT.

- 700	146,000	SQ. FT	300	SQ.FT/PERS	=	486	PERS
- 707	77,000	SQ. FT	300	" - " - "	=	250	" - "
- 730	214,000	SQ. FT	300	" - " - "	=	713	" - "
- 840	142,000	SQ. FT	300	" - " - "	=	473	" - "

TOTAL PERS = 1922 PERS

PEAK ENERGY USAGE = BOILER CAPACITY = 2.66 MBTUH

ENERGY CONSUMPTION

1922 PERS × 1 GAL/PERS-DAY = 1922 GAL/DAY

1922 GAL/DAY × 8.33#/GAL × (140°-60°F) = 1280,820 BTU/D.

OR = 53,367.53 BTU/HR

PEAK ENERGY USAGE

1922 PERS × 0.4 GAL/PERS-HR = 768.8 GAL/HR

768.8 GAL/HR × 8.33#/GAL × (140-60°F) = 512,328 BTUH

E M C ENGINEERS, INC.

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JOB 3002-000

SHEET NO. ______ OF ______

CALCULATED BY KC DATE 3-14-91

CHECKED BY ______ DATE ______

SCALE DOMESTIC HW LOAD CALC.

BLDG. 914

BOILER # 1 SERVE DOMESTIC HW HAS CAPACITY OF 1,610,000 BTUH

∴ PEAK BLDG DOMESTIC HW LOAD = CAP. 1,610,000 BTUH

MESS HALL

140°F 180 MEALS(MAX.)/HR X 1.5 GAL/MEAL = 270 GAL/HR

180°F 180 MEALS(MAX.)/HR X 1.3 GAL/MEAL = 234 GAL/HR

~~270 GAL/HR X 8.33#/GAL X (140-60°F) = 180,000 BTUH~~

~~234 GAL/HR X 8.33#/GAL X (180-40°F) = 272,900 BTUH~~

~~TOTAL = 452,800 BTUH~~

~~REMAINING FOR DOMESTIC IS: 1.61 - .4528 MBTUH~~

~~= 1.157 MBTUH~~

PEOPLE OCCUPY BLDG

ADMIN - 49 PERS @ 1 GAL/DAY

BARRACK - 274 PERS @ 13.1 GAL/DAY

TOTAL DOMESTIC LOAD IS 49 + (274 X 13.1) = 408 GAL/DAY

TOTAL BLDG HW LOAD ARE:

140°F HW - (408 + 270) GAL/DAY X 8.33#/GAL X (140-60°F) = 271,891 BTU/DAY

180°F HW - (234) GAL/DAY X 8.33#/GAL X (180-40°F) = 233,906 BTU/DAY

TOTAL = 505,797 BTU/DAY

OR 21,074.9 BTU/HR

E M C ENGINEERS, INC.	JOB 3002-000
Denver • Colorado Springs • Atlanta • West Germany	SHEET NO. ____ OF ____
	CALCULATED BY KC DATE 3/13/91
	CHECKED BY ____ DATE ____
	SCALE DOMESTIC HW LOAD CALC.

BLDG. 2812

13 BARRACKS @ 13,000 SQ. FT. = 169,000 SQ. FT.
1 MESS HALL @ 9,000 SQ. FT. = 9,000 SQ. FT.

BARRACK (170 SQ. FT./PER) = 169,000/170 ≈ 995 PERS

MESS HALL

~~375 MEALS (MAX.)/HR X 1.5 GAL/MEAL = 562 GPH (140°F)~~
~~375 MEALS (MAX.)/HR X 1.3 GAL/MEAL = 491 GPH (180°F)~~

PEAK ENERGY USAGE

DOMESTIC HW
3.8 GAL/PERS-HR X 995 PERS = 3,781 GPH

140°F (3781 + ~~562~~) GPH X 8.33#/GAL X (140-60°F) = 2,519,658 BTUH

~~180°F (491) GPH X 8.33#/GAL X (180°-40°F) = 572,604 BTUH~~

TOTAL = 2,519,658 BTUH

ENERGY CONSUMPTION

BARRACK 13.1 GAL/DAY-PERS X 995 = 13,035 /DAY
~~MESS HALL 3 MEAL/DAY~~
~~3 X 375 MEALS (MAX.)/DAY X 2.4 GAL/MEAL = 2700 GAL/DAY~~
~~3 X 375 MEALS (MAX.)/DAY X 1.3 GAL/MEAL = 1473 GAL/DAY~~

140°F HW - (13,035 ~~+ 2700~~) GAL/DAY X 8.33#/DAY X (140-60°F) = 8,686,524 BTU/DAY

~~180°F HW - 1473 GAL/DAY X 8.33#/GAL X (180-40°F) = 1,717,813 BTU/DAY~~

TOTAL = 8,686,524 BTU/DAY
OR = 361,938 BTU/HR

E M C ENGINEERS, INC.

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JOB 3002-000

SHEET NO. ______ OF ______

CALCULATED BY KC DATE 3-20-91

CHECKED BY ______ DATE ______

SCALE DOMESTIC HW LOAD CALC.

BLDG 2812 MESS HALL KITCHEN LOAD

PEAK OF KITCHEN LOAD EQUAL BOILER MAX. OUTPUT 2.25 MBH

ENERGY CONSUMPTION.

3x 375 MEALS (MAX.)/DAY X 2.4 GAL/MEAL-DAY = 2700 GPD 140°F

3x 375 MEALS (MAX.)/DAY X 2 GAL/MEAL-DAY = 2250 GPD 180°F

140°F 2700 GPD x 8.33#/GAL x (140°F - 60°F) = 1,799,280 BTU/DAY

180°F 2250 GPD x 8.33#/GAL x (180°F - 60°F) = 2,249,100 BTU/DAY

TOTAL = 4,048,380 BTU/DAY

JOB 3002-000

E M C ENGINEERS, INC.

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SHEET NO. ______ OF ______

CALCULATED BY KC DATE 3-20-91

CHECKED BY ______ DATE ______

SCALE DOMESTIC HW LOAD CALC.

BLDG 4701

SERVE BLDG 4700 WHICH HAS SQ. Ft. OF 197,200

PEAK ENERGY CALC.

KITCHEN HW (ESTIMATE):

COOKING 375 MEALS (MAX.)/HR × 1.5 GAL/MEAL = 562 GPH 140°F

WASHING 375 MEALS (MAX.)/HR × 1.3 GAL/MEAL = 491 GPH 180°F

DOMESTIC HW. (ESTIMATE):

No. OF PEOPLE IN BLDG $= \frac{197,200 \text{ SQ FT.}}{250 \text{ SQ FT./PER}} = 789.$

789 PERS × 0.4 GAL/PER-HR = 315.6 GPH

140°F (562+315.6) GPH × 8.33#/GAL × (140-60°F) = 584,833 BTU/HR.

180°F 491 GPH × 8.33#/GAL × (180-60°F) = 490,803 BTU/HR

TOTAL = 1,075,636 BTU/HR

ENERGY CONSUMPTION CALC.

KITCHEN HW (ESTIMATE):

COOKING 2×375 MEALS (MAX.)/DAY × 2.4 GAL/MEAL = 1800 GPD 140°F

WASHING 2×375 MEALS (MAX.)/DAY × 2 GAL/MEAL = 1500 GPD 180°F

DOMESTIC HW (ESTIMATE):

789 PERS × 1 GAL/PERS-DAY = 789 GAL

140°F (1800+789) GPD × 8.33#/GAL × (140-60°F) = 1,725,309 BTU/DAY

180°F 1500 GPD × 8.33#/GAL × (180-60°F) = 1,499,400 BTU/DAY

TOTAL = 3,224,709 BTU/DAY

OR = 134,363 BTU/HR

E M C ENGINEERS, INC.

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JOB 3002-000

SHEET NO. ______ OF ______

CALCULATED BY KC DATE 3/13/91

CHECKED BY ______ DATE ______

SCALE DOMESTIC HW LOAD CALC.

BLDG 5900

BLDG	SQ. Ft. BARRACK	SQ. Ft. ADMIN	SQ. Ft. MESS HALL
6007	189,300	19,000	12,500
6050	↓	↓	↓
5955			
5960			
5970			
	946,500	95,000	62,500

BARRACK 170 SQ. FT./PERS = 946,500/170 = 5,568 PERS

ADMIN 250 SQ. FT./PERS = 95,000/250 = 380 PERS

KITCHEN

140°F HW: 187 MEALS (MAX.)/HR. × 1.5 GAL/MEAL = 281 GPH

180°F HW: 187 MEALS (MAX.)/HR × 1.3 GAL/MEAL = 246 GPH

PEAK ENERGY USAGE

3.8 GAL/PERS-HR × 5568 PERS = 21,158 GPH

0.4 GAL/PERS-HR × 380 PERS = 152 GPH

TOTAL = 21310 GPH

140°F HW:

[(5× 281)+(21,310 GPH)] × 8.33#/GAL × (140°−60°F) = 15,137,276 BTUH

180°F HW

5×[(246) GPH × 8.33#/GAL × (180°F − 40°F)] = 1,434,462 BTUH

TOTAL = 16,571,702 BTUH

≅ 16,571,700 BTUH

JOB 3002-000

E M C ENGINEERS, INC.
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SHEET NO. ______ OF ______

CALCULATED BY KL DATE 3/13/91

CHECKED BY ______ DATE ______

SCALE DOMESTIC HW LOAD CALC.

BLDG 5900 (CONTINUED)

BARRACK 13.1 GAL/DAY-PERS X 5568 PERS = 72,940 GAL/DAY

ADMIN 1 GAL/DAY-PERS X 380 PERS = 380 GAL/DAY

KITCHEN:

140°F 3 X 187 MEALS/DAY 2.4 GAL/MEAL = 1350 GAL/DAY

180°F 3 X 187 MEALS/DAY X 1.3 GAL/MEAL = 731 GAL/DAY

ENERGY CONSUMPTION

140°F 72940 + 380 + 1350 GAL/DAY X 8.33#/GAL X (140-60°F) = 49,760,000 BTU/DAY

180°F 731 GAL/DAY X 8.33 GAL/DAY X (180-40°F) = 852,500 BTU/DAY

TOTAL = 50,612,580 BTU/DAY

OR = 2108,857 BTU/HR

E M C ENGINEERS, INC.
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JOB 3002-000
SHEET NO. ______ OF ______
CALCULATED BY KC DATE 3/13/91
CHECKED BY ______ DATE ______
SCALE DOMESTIC HW LOAD CALC.

BLDG 6003

DOMESTIC HW (ESTIMATE):

		SQ. FT.			SQ. FT.
6009	BARRACK	35,000	6002	ADMIN	23,000
6010	↓	35,000	6004	" — "	23,000
6012	↓	78,000		TOTAL	46,000
6014	↓	35,000			
6015	↓	35,000	6120	CLASS ROOM	16,000
6017	↓	69,000	6080	STORE HOUSE	1,300
6018	↓	69,000		TOTAL	17,300
	TOTAL	356,000 SQ.FT.	6011	MESS HALL	2,000

BARRACK (170 SQ.FT/PERS) : 356,000 SQ.FT. = 2100 PERS
ADMIN (250 SQ.FT/PERS) : 46,000 SQ.FT = 185 PERS
CLASSROOM (300 SQ.FT/PERS) : 17,300 SQ.FT = 58 PERS
[ADMIN/CLASSROOM] TOTAL = 243 PERS

MESSHALL KITCHEN

(140°F HW) 375 MEAL (MAX.)/HR × 1.5 GAL/MEAL = 562 GPH
(180°F HW) 375 MEAL (MAX.)/HR × 1.3 GAL/MEAL = 491 GPH

DOMESTIC HW

BARRACK (140°F HW) 3.8 GAL/PERS-HR × 2100 PERS = 7980 GPH
ADMIN/CLS ROOM 0.4 GAL/PERS-HR × 243 PERS = 97 GPH
8077 GPH

PEAK ENERGY USAGE

[140°F HW] (562 + 8077) × 8.33 #/GAL × (140°F − 60°F) = 5,757,030 BTUH
[180°F HW] 491 GPH × 8.33 #/GAL × (180°F − 40°F) = 572,604 BTUH

TOTAL ≃ 6,330,000 BTUH

E M C ENGINEERS, INC.

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JOB 3002-000

SHEET NO. ______ OF ______

CALCULATED BY KC DATE 3/13/91

CHECKED BY ______ DATE ______

SCALE DOMESTIC HW LOAD CALC.

BLDG 6003 (CONTINUED)

BARRACK

13.1 GAL/DAY/PERS X 2100 PERS = 27,510 GAL/DAY

ADMIN/CLASS ROOM

1 GAL/DAY/PERS X 243 PERS = 243 GAL/DAY

MESS HALL 3-MEALS/DAY

140°F 3X375 MEALS/DAY × 2.4 GAL/MEAL = 2700 GAL/DAY

180°F 3X375 MEALS/DAY × 1.3 GAL/MEAL = 1462 GAL/DAY

ENERGY CONSUMPTION

140°F 27510+243+2700 GAL/DAY × 8.33#/GAL × (140°F−60°F)

= 20,293,879 BTU/DAY

180°F 1462 GAL/DAY × 8.33#/GAL × (180°F − 40°F) = 1,704,984 BTU/DAY

TOTAL = 21,998,863 BTU/DAY

OR = 916,619 BTU/HR

DISTRIBUTION LOSS CALCULATIONS

E M C ENGINEERS, INC.
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JOB	3002.000
SHEET NO.	OF
CALCULATED BY	KC DATE 3/12/91
CHECKED BY	DATE
SCALE	

DISTRIBUTION LOSS CALCULATIONS

	1991	TOTAL HR
JAN	31 DAYS	744
FEB	28	672
MAR	31	744
APR	30	720
MAY	31	744
JUN	30	720
JUL	31	744
AUG	31	744
SEP	30	720
OCT	31	744
NOV	30	720
DEC	31	744
		8760

730	- HEATING	156,400	BTUH
2812	- HEATING	240,800	BTUH
4701	- HEATING	11,160	BTUH
5900	- HEATING	3,530,000	BTUH
6003	- HEATING	1,553,400	BTUH

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6.5" PIPE

PIPE THICKNESS = .031

$r_a = \frac{.5417}{2} = .2708'$

$r_b = \frac{.5417 + 2(.031)}{2} = .3019'$

$r_c = \frac{.5417 + 2(.031) + 2(.33)}{2} = .6352'$

5900 HWS

$$q = \frac{2\pi(10{,}714)(350-60)}{\frac{\ln\left(\frac{.3019}{.2708}\right)}{28} + \frac{\ln\left(\frac{.6352}{.3019}\right)}{.45} + \frac{1}{.6352(.21)}}$$

$$= 2.133 \text{ MBTU/HR}$$

HWR

$$q = \frac{2\pi(10{,}714)(250-60)}{9.1538}$$

$$= 1.3973 \text{ M BTU/HR}$$

$\boxed{\text{HW TOTAL} = 3.530 \text{ M BTU/HR}}$

9.5" PIPE

$r_a = \frac{.792}{2} = .3958'$

$r_b = \frac{.792 + 2(.031)}{2} = .4268'$

$r_c = \frac{.792 + 2(.031) + 2(.33)}{2} = .7602$

CWS

$$q = \frac{2\pi(10{,}714)(40-60)}{\frac{\ln\frac{r_b}{r_a}}{28} + \frac{\ln\frac{r_c}{r_b}}{.45} + \frac{1}{r_c(.21)}}$$

$$= 0.1783 \text{ MBTU/HR} = 14.861 \text{ TONS}$$

CWR

$$q = \frac{2\pi(10{,}714)(50-60)}{7.5495}$$

$$= 0.08917 \text{ MBTU/HR} = 7.4307 \text{ TONS}$$

$\boxed{\text{CW TOTAL} = 22.292 \text{ TON}} = 0.26751 \text{ M BTU/HR}$

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BLDG 6003

STMS $$q = \frac{2\pi(7300)(250-60)}{\frac{\ln\left(\frac{.3019}{.2708}\right)}{28} + \frac{\ln\left(\frac{.6352}{.3019}\right)}{.45} + \frac{1}{.6352(.21)}}$$

$= 0.9521$ MBTU/HR

6.5" PIPE (AVG)

PIPE THICKNESS = .031'

$r_a = \frac{.5417}{2} = .2708'$

$r_b = \frac{.5417 + 2(.031)}{2} = .3019'$

$r_c = \frac{.5417 + 2(.031) + 2(.33)}{2} = .6352'$

STMR $$q = \frac{2\pi(7300)(180-60)}{9.1538}$$

$= 0.6013$ MBTU/HR

$\boxed{\text{STM TOTAL} = 1.5534 \text{ MBTU/HR}}$

CWS $q = \frac{2\pi(6500)(48-60)}{}$ N/A

5.25" PIPE (AVG)

$r_a = \frac{.4375}{2} = .2188'$

BLDG 2812

HWS $$q = \frac{2\pi(4110)(190-60)}{\frac{\ln\left(\frac{r_b}{r_a}\right)}{28} + \frac{\ln\left(\frac{r_c}{r_b}\right)}{.45} + \frac{1}{.2294(.21)}}$$

$q = 0.1491$ MBTU/HR

2" PIPE (AVG) PIPE THICK. = .021'

INSUL THICK = 1.5"

$r_a = \frac{.1667}{2} = 0.0833'$

$r_b = \frac{.1667 + 2(.021)}{2} = 0.1043'$

$r_c = \frac{.1667 + 2(.021) + 2(.125)}{2} = .2294'$

HWR $$q = \frac{2\pi(4110)(140-60)}{22.518}$$

$q = 0.09175$ MBTU/HR

$\boxed{\text{TOTAL PIPE LOSSES} = 0.2408 \text{ MBTU/HR}}$

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730 TO 700 — ASHRAE 22.19 — $26 \frac{BTU}{h \cdot ft}(1080 ft) = 28{,}080$ BTU/hr

FROM 700 — $20 \frac{BTU}{Hr \cdot ft}(1080 ft) = 21{,}600$ BTU/HR

TO 840 — $26 \frac{BTU}{HR \cdot ft}(1120 ft) = 29{,}120$ BTU/HR

FROM 840 — $20 \frac{BTU}{HR}(1120) = 22{,}400$ BTU/HR

TO 707 — $26 \frac{BTU}{HR}(1200) = 31{,}200$ BTU/HR

FROM 707 — $20 \frac{BTU}{HR}(1200) = 24{,}000$ BTU/HR

TOTAL PIPING HEAT LOSSES FOR HW = $\boxed{156{,}400 \text{ BTU/HR}}$

BLDG 4701 — INSUL THICKNESS 3.5" — 4.5" PIPE AVG

STMS $42 \frac{BTU}{HR \cdot ft}(180 ft) = 7{,}560$ BTU/HR

STMR $20 \frac{BTU}{HR \cdot ft}(180 ft) = 3{,}600$ BTU/HR

$\boxed{\text{TOTAL} = 11{,}160 \text{ BTU/HR}}$

ELECTRICAL ENERGY RATE CALCULATION

ELECTRICAL ENERGY RATE CALCULATION

SERVICE MONTHS FY 90	ELECTRICAL ENERGY TOTAL (kWh)	FEDERAL GENERATED ENERGY (kWh)	THERMAL ENERGY (kWh)	FEDERAL GENERATED ENERGY COST ($)	THERMAL ENERGY COST ($)	ELECTRIC ENERGY RATE ($/kWh)	ELECTRIC ENERGY RATE COMMENT
[A]	[B]	[C]	[D]	[H]	[I]	[M]	
OCT '89	10,859,520	9,758,900	1,100,620	$39,035.60	$26,965.19	0.0245	COLUMN [I]/[D]
NOV	9,049,600	4,630,583	4,419,017	$18,522.33	$105,406.81	0.0239	COLUMN [I]/[D]
DEC	10,146,864	0	10,146,864	$0.00	$241,251.84	0.0238	COLUMN [I]/[D]
JAN '90	11,481,680	7,041,950	4,439,730	$28,167.80	$94,339.83	0.0212	COLUMN [I]/[D]
FEB	9,377,648	9,377,648	0	$37,510.59	$0.00	0.0040	COLUMN [H]/[B]
MAR	10,158,176	10,158,176	0	$40,632.70	$0.00	0.0040	COLUMN [H]/[B]
APR	9,527,263	9,527,263	0	$38,109.05	$0.00	0.0040	COLUMN [H]/[B]
MAY	11,453,400	11,453,400	0	$45,813.60	$0.00	0.0040	COLUMN [H]/[B]
JUN	17,358,264	17,358,264	0	$69,433.06	$0.00	0.0040	COLUMN [H]/[B]
JUL	17,884,272	17,884,272	0	$71,537.09	$0.00	0.0040	COLUMN [H]/[B]
AUG	18,376,344	10,444,935	7,931,409	$41,779.74	$199,704.95	0.0252	COLUMN [I]/[D]
SEP	16,170,504	5,437,224	10,733,280	$21,748.90	$240,071.27	0.0224	COLUMN [I]/[D]
					AVERAGE	**0.0137**	

COMMENT: ON MONTHS WHERE THERE ARE THERMAL ENERGY CHARGES, THE ELECTRICAL ENERGY RATES IS COLUMN [I] DIVIDED BY COLUMN [D]
ON MONTHS WHERE THERE ARE NO THERMAL ENERGY CHARGES THE ELECTRICAL ENERGY RATE IS COLUMN [H] DIVIDED BY COLUMN [B].

APPENDIX C

CENTRAL PLANT EFFICIENCY CALCULATIONS

APPENDIX C.1

CHILLERS EFFICIENCY CALCULATIONS

CHILLER TESTED CAPACITY

CHILLER TEST CAPACITY

[CHL-TST.WK3]

Chiller Information			Rated Values						Measured Values					
			Out		In	Temp	Temp							
Bldg No.	Chiller No.	Supplier	(TONS)	(MBH)	(kW)	Avg CHWR (°F)	Avg CHWS (°F)	GPM	In (kW)	Out (Tons)	Calculate (kW/Tons)	Out (MBH)	Percent Load	Elec. Acc. (kW)
730	1	TRANE	800	9600	640kW	61	49.9	1364	564.00	630.85	0.89	7570	79%	224.00
730	3	TRANE	320	3840	N/A	57.66	43	472.5	214.60	288.62	0.74	3463	90%	89.60
730	4	TRANE	320	3840	NO									89.60
914	1	TRANE	400	4800	240kW	50.82	46.44	726	163.00	132.50	1.23	1590	33%	112.00
2812	1	CARRIER	372	4464	NO	49.7	41.8	530	143.00	174.46	0.82	2094	47%	104.16
3442	1	TRANE	600	7200	360kW	54.53	45.18	1132	297.80	441.01	0.68	5292	74%	168.00
3442	2	TRANE	600	7200	360kW	55.47	45.38	1216.8	309.90	511.56	0.61	6139	85%	168.00
4701	1	CARRIER	275	3300	N/A	47.8	42	535	169.70	129.29	1.31	1551	47%	77.00
4701	2	CARRIER	275	3300	N/A	48.5	43.5	690	105.40	143.75	0.73	1725	52%	77.00
5676	1	CARRIER	170	2040	N/A	56.4	52.4	468	119.50	78.00	1.53	936	46%	47.60
5678	1	TRANE	190	2280	143kW	57.7	53.5	892	106.00	156.10	0.68	1873	82%	53.20
5900	1	CARRIER	400	4800	N/A	58.95	46.18	676	324.00	359.69	0.90	4316	90%	112.00
5900	2	WESTINGHO	400	4800	316kW	52.5	41.7	728.2	309.00	327.69	0.94	3932	82%	112.00
5900	3	CARRIER	400	4800	284kW	54.4	45.1	717	230.80	277.84	0.83	3334	69%	112.00
5900	4	McQUAY	450	5400	352kW	53.95	43.44	854	344.70	373.98	0.92	4488	83%	126.00
5900	5	CARREY	400	4800	272kW	53.3	42.77	640.5	238.00	281.02	0.85	3372	70%	112.00
6003	1	TRANE	400	4800	N/A	N/A	N/A	N/A	N/A	N/A	N/A		0%	112.00
6003	2	TRANE	450	5400	270kW	N/A	N/A	540	N/A	N/A	N/A	0	0%	126.00
6003	3	TRANE	450	5400	270kW	N/A	N/A	540	N/A	N/A	N/A	0	0%	126.00

CHILLER AUXILIARY LOAD CALCULATIONS

CHILLER AUX. LOADS

BUILDING NUMBER	CHILLER NO.	CHILLED WATER PUMP (kW)	CONDENSER WATER PUMP (kW)	COOLING TOWER (kW)	TOTAL AUX. LOADS (kW)
730	1	91.0	37.2	23.0	279.9
		93.0	35.7		
	3	20.2	25.4	8.6	54.2
	4				NA
TOTAL		204.2	98.3	31.6	334.1
914	1	29.8	9.4	8.6	47.8
2812	1	14.4	17.8	11.8	44.0
3442	1	44.0	24.0	24.0	92.0
	2	43.8	22.1	24.0	89.9
TOTAL		87.8	46.1	48.0	181.9
4701	1	33.1	24.8	10.5	68.4
	2			10.0	10.0
TOTAL		33.1	24.8	20.5	78.4
5676	1	8.0	7.0	5.4	20.4
5678	1	13.8	6.0	5.4	25.2
5900	1	39.5	17.6	19.2	76.3
	2	38.7	23.0	14.2	75.9
	3	41.9	24.1	14.0	80.0
	4	54.1	26.6	20.2	100.9
	5	43.6	22.0	17.1	82.7
TOTAL		217.8	113.3	84.7	415.8
6003	1				NA
	2	26.6	19.0	18.0	63.6
	3	28.0	19.0	18.0	65.0
TOTAL		54.6	38.0	36.0	128.6

[CHILAUX.WK3]

CHILLER OUTPUT CALCULATIONS

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CHILLER OUTPUT CALCULATIONS

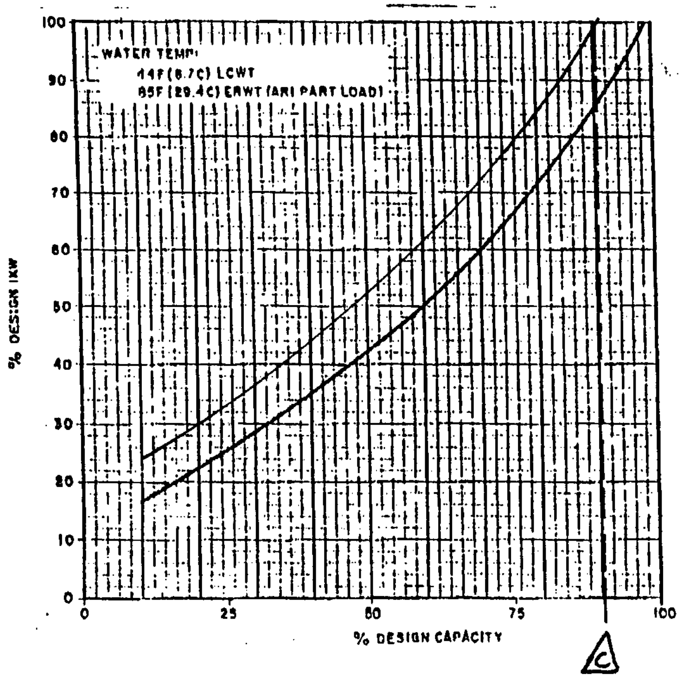
AT 90% EFFICIENCY

Building No.: 914
Chiller No.: 1
Chiller Mfg.: TRANE

Design Rating:
Tons: 400 MBtu: 4800
Amps: 354 Volts: 460

Test Reading:
kW: NA Tons: NA
PF: 88

TYPICAL PART LOAD PERFORMANCE CURVE



Calculations:

Rated kW Input = $\frac{\sqrt{3} \text{ X Volt X Rated Amps X PF}}{1000}$ = $\frac{\sqrt{3} \times 460 \times 354 \times .88}{1000}$

= 248 kW

Tested kW Input = NA kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = NA = NA %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = NA = NA %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C):

90 % X Rated Tons = .9 X 400
= 360 Tons; or 4320 MBtu

Max. Output MBtu:	4320	**MBtu**
Max. kW Input:	248	**kW**

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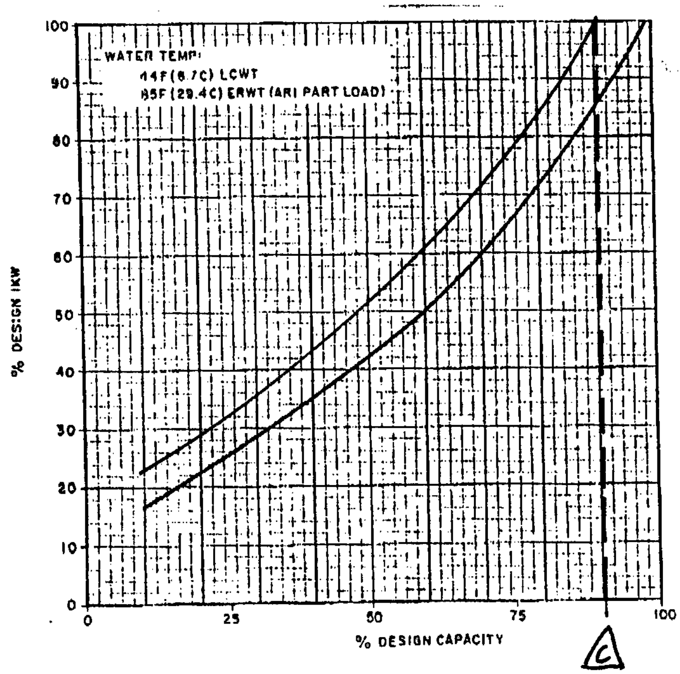
CHILLER OUTPUT CALCULATIONS

AT 90% EFFICIENCY

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 5676
Chiller No.: 1
Chiller Mfg.: CARRIER

Design Rating:
Tons: 170 MBtu: 4500
Amps: 211 Volts: 460

Test Reading:
kW: N/A Tons: N/A
PF: 87

Calculations:

Rated kW Input = $\frac{\sqrt{3} \text{ X Volt X Rated Amps X PF}}{1000}$ = $\frac{\sqrt{3} \times 460 \times 211 \times .87}{1000}$

= 146.3 kW

Tested kW Input = N/A kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = N/A = N/A %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = N/A = N/A %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :

90 % X Rated Tons = .9 x 170
= 153 Tons; or 1836 MBtu

Max. Output MBtu:	1836	MBtu
Max. kW Input:	146.3	kW

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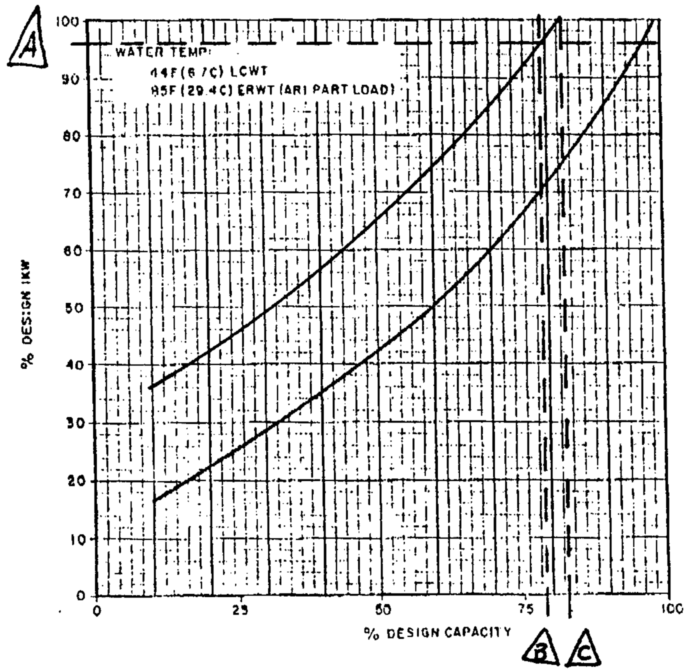
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 730
Chiller No.: 1
Chiller Mfg.: TRANE

Design Rating:
Tons: 800 MBtu: 9600
Amps: 821 Volts: 460

Test Reading:
kW: 564 Tons: 631
PF: 90

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000}$ = $\frac{\sqrt{3} \times 460 \times 821 \times .9}{1000}$

= 589 kW

Tested kW Input = 564 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{564}{589}$ = 95.8 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{631}{800}$ = 79 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :
83 % X Rated Tons = .83 x 800
= 664 Tons; or 7968 MBtu

Max. Output MBtu:	7968	MBtu
Max. kW Input:	589	kW

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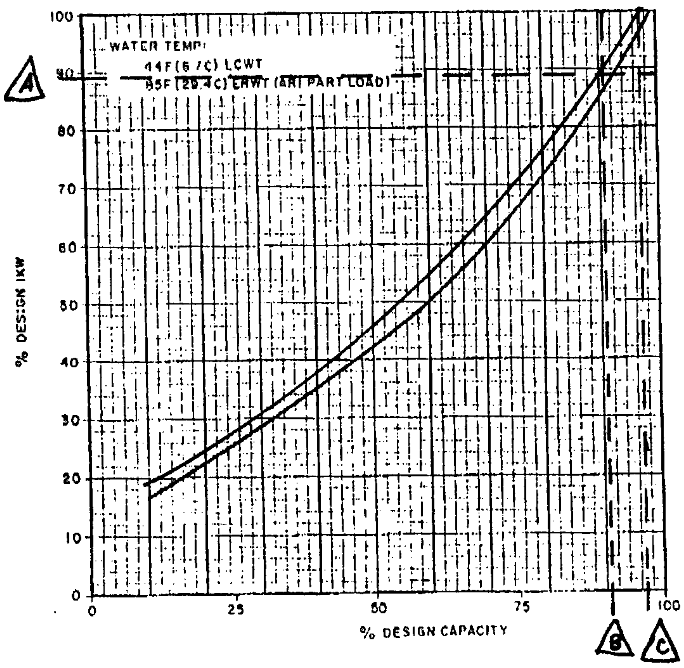
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 730
Chiller No.: 3 (NORTH)
Chiller Mfg.: TRANE

Design Rating:
Tons: 320 MBtu: 3840
Amps: 367 Volts: 480

Test Reading:
kW: 214.6 Tons: 288.6
PF: 80

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000}$ = $\frac{\sqrt{3} \times 480 \times 367 \times .8}{1000}$

= 244.1 kW

Tested kW Input = 214.6 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{214.6}{244.1}$ = 88 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{288.6}{320}$ = 90.2 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :
97 % X Rated Tons = .97X 320
= 310 Tons; or 3725 MBtu

Max. Output MBtu:	3725	MBtu
Max. kW Input:	244	kW

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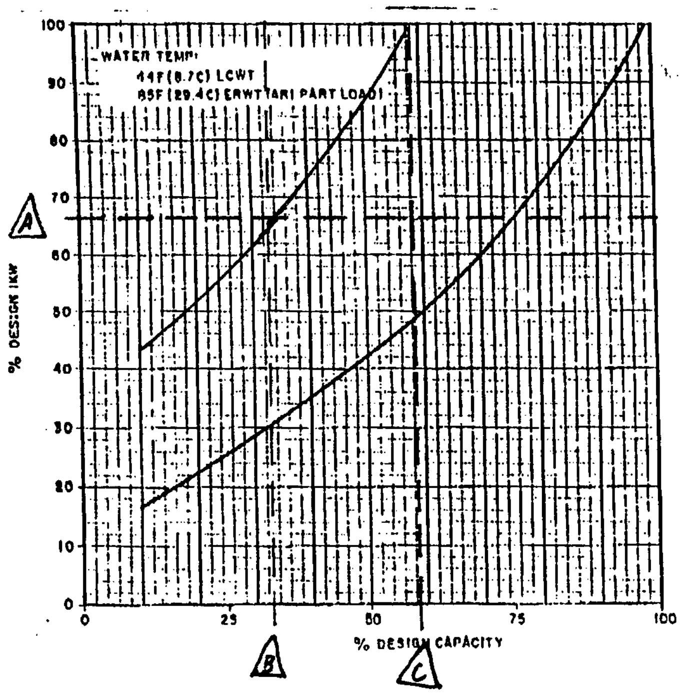
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 914
Chiller No.: 1
Chiller Mfg.: TRANE

Design Rating:

Tons:	400	MBtu:	4800
Amps:	354	Volts:	460

Test Reading:

kW:	163	Tons:	133
PF:	.88		

Calculations:

Rated kW Input = $\frac{\sqrt{3} \text{ X Volt X Rated Amps X PF}}{1000}$ = $\frac{\sqrt{3} \times 460 \times 354 \times .88}{1000}$

= 248 kW

Tested kW Input = 163 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{163}{248}$ = 66 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{133}{400}$ = 33 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C):

58 % X Rated Tons = .58 x 400

= 232 Tons; or 2784 MBtu

Max. Output MBtu:	2784	**MBtu**
Max. kW Input:	248	**kW**

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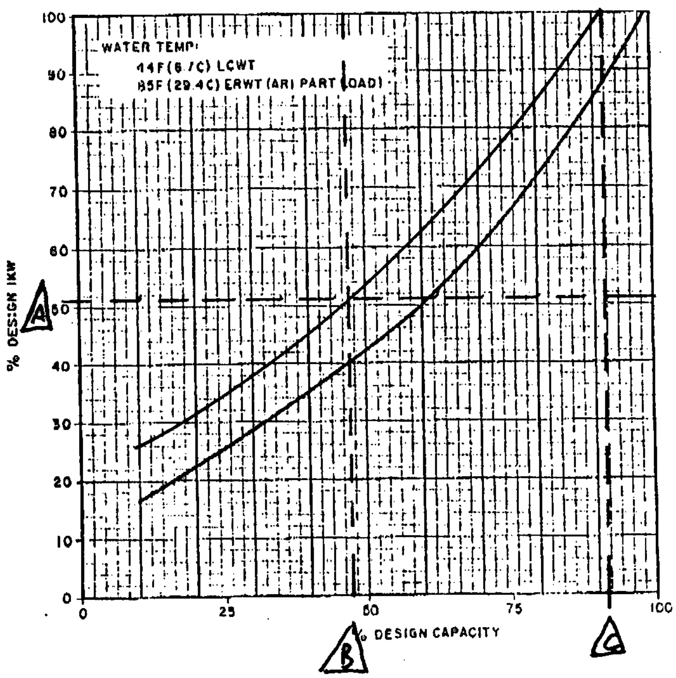
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 2812
Chiller No.: 1
Chiller Mfg.: CARRIER

Design Rating:

Tons: 372 MBtu: 4464
Amps: 410 Volts: 480

Test Reading:

kW: 143 Tons: 174.5
PF: 81.3

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000}$ = $\frac{\sqrt{3} \times 480 \times 410 \times .813}{1000}$

= 277 kW

Tested kW Input = 143 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{143}{277}$ = 51.6 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{174.5}{372}$ = 47 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :

92 % X Rated Tons = .92 X 372
= 342 Tons; or 4107 MBtu

Max. Output MBtu: 4107 MBtu
Max. kW Input: 277 kW

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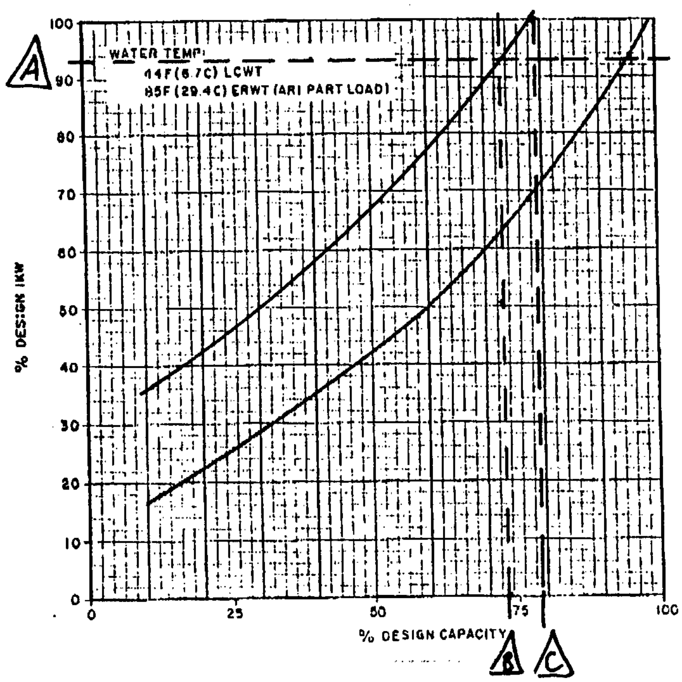
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 3442
Chiller No.: 1
Chiller Mfg.: TRANE

Design Rating:
Tons: 600 MBtu: 7200
Amps: 502 Volts: 460

Test Reading:
kW: 297.8 Tons: 441
PF: 80

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000} = \frac{\sqrt{3} \times 460 \times 502 \times .8}{1000}$

= 320 kW

Tested kW Input = 297.8 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}} = \frac{297.8}{320} = 93$ %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}} = \frac{441}{600} = 73.5$ %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :
80 % X Rated Tons = .8 X 600
= 480 Tons; or 5760 MBtu

Max. Output MBtu: 5760 MBtu
Max. kW Input: 320 kW

JOB 3002.000 Ft. Sill Central Plant Study

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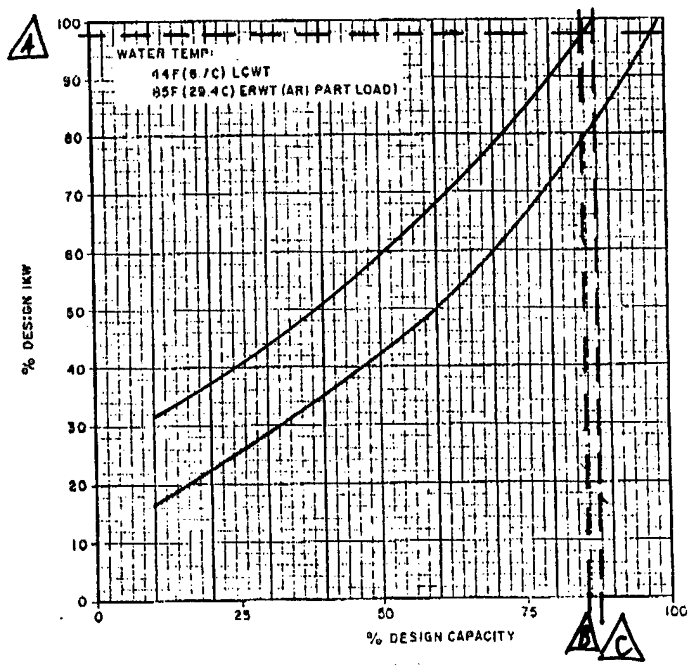
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 3442
Chiller No.: 2
Chiller Mfg.: TRANE

Design Rating:

Tons: 600 MBtu: 7200

Amps: 502 Volts: 460

Test Reading:

kW: 310 Tons: 512

PF: 80

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000}$ = $\frac{\sqrt{3} \times 460 \times 502 \times .8}{1000}$

= 320 kW

Tested kW Input = 310 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{310}{320}$ = 96.9 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{512}{600}$ = 85.3 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :

88 % X Rated Tons = .88 X 600

= 528 Tons; or 6336 MBtu

Max. Output MBtu:	6336	MBtu
Max. kW Input:	320	kW

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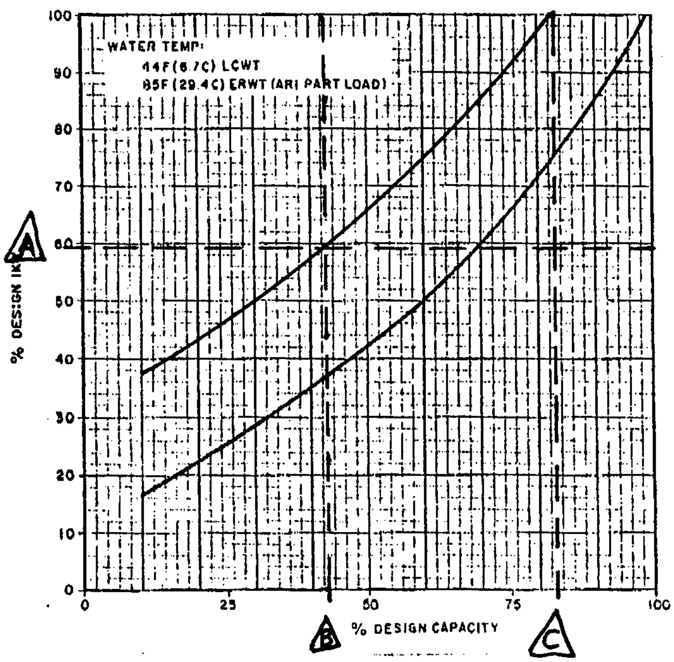
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 4701
Chiller No.: 1
Chiller Mfg.: CARRIER

Design Rating:
Tons: 305 MBtu: 3660
Amps: 378 Volts: 460

Test Reading:
kW: 169.7 Tons: 129.3
PF: 95.3

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000}$ = $\frac{\sqrt{3} \times 460 \times 378 \times .953}{1000}$

= 287 kW

Tested kW Input = 169.7 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{169.7}{287}$ = 59 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{129.3}{305}$ = 42 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :
83 % X Rated Tons = .83 x 305
= 253 Tons; or 3038 MBtu

Max. Output MBtu:	3030	MBtu
Max. kW Input:	287	kW

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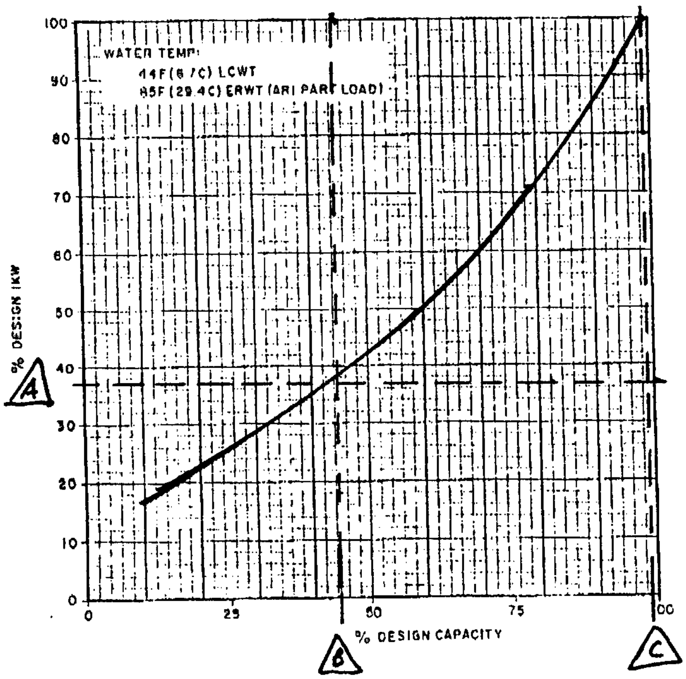
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 4701
Chiller No.: 2
Chiller Mfg.: CARRIER

Design Rating:
Tons: 305 MBtu: 3660
Amps: 378 Volts: 460

Test Reading:
kW: 105.4 Tons: 144
PF: .97

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000} = \frac{\sqrt{3} \times 460 \times 378 \times .97}{1000}$

= 292 kW

Tested kW Input = 105.4 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}} = \frac{105.4}{292} = 36.1$ %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}} = \frac{144}{305} = 47$ %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C):

99 % X Rated Tons = .99 X 305
= 302 Tons; or 3623 MBtu

Max. Output MBtu:	3623	MBtu
Max. kW Input:	292	kW

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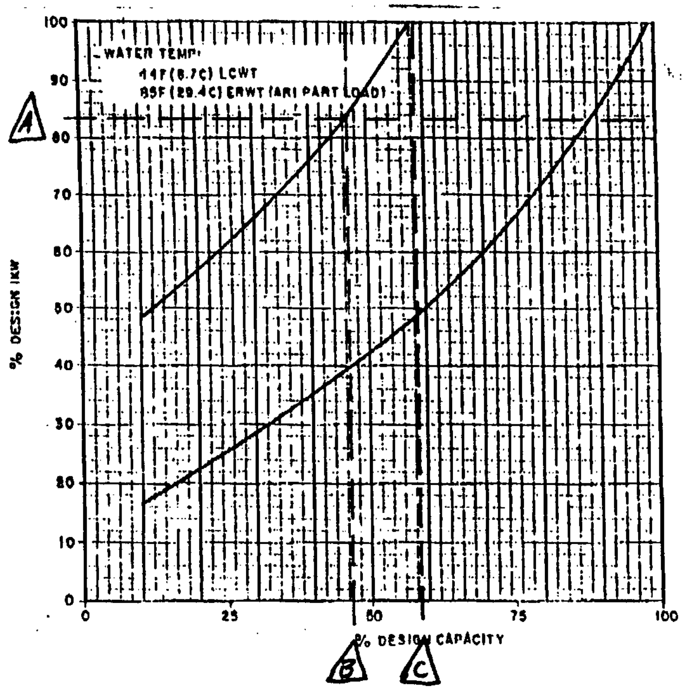
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 5676
Chiller No.: 1
Chiller Mfg.: CARRIER

Design Rating:

Tons: 170 MBtu: 4500
Amps: 211 Volts: 460

Test Reading:

kW: 119.5 Tons: 78
PF: 86

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000} = \frac{\sqrt{3} \times 460 \times 211 \times .86}{1000}$

= 144.6 kW

Tested kW Input = 119.5 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}} = \frac{119.5}{144.6}$ = 83 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}} = \frac{78}{170}$ = 46 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C):

58 % X Rated Tons = .58 X 170
= 99 Tons; or 1183 MBtu

Max. Output MBtu:	1183	MBtu
Max. kW Input:	144.6	kW

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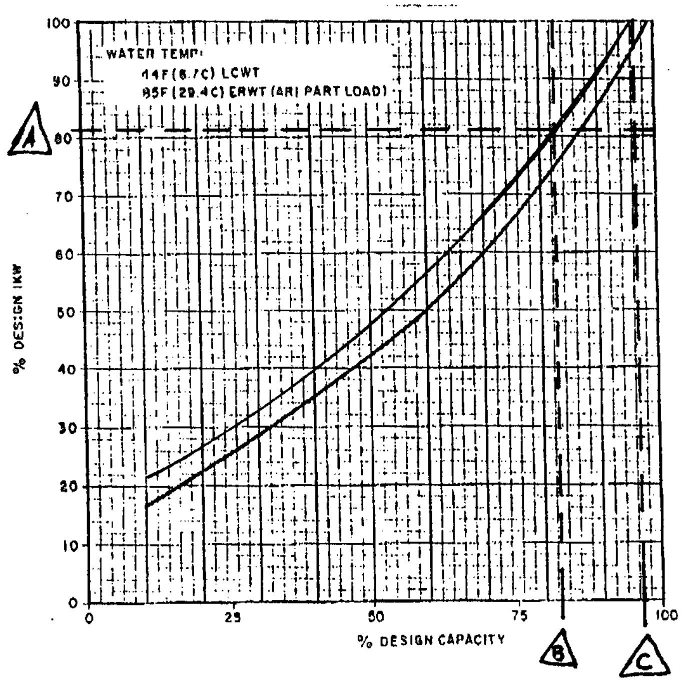
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 5678
Chiller No.: 1
Chiller Mfg.: TRANE

Design Rating:

Tons: 190 MBtu: 2280
Amps: 195 Volts: 460

Test Reading:

kW: 106 Tons: 156
PF: 83.5

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000}$ = $\frac{\sqrt{3} \times 460 \times 195 \times 83.5}{1000}$

= 129.7 kW

Tested kW Input = 106 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{106}{129.7}$ = 81.7 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{156}{190}$ = 82.1 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :

96 % X Rated Tons = .96 X 190
= 182 Tons; or 2188 MBtu

Max. Output MBtu: 2188 MBtu
Max. kW Input: 129.7 kW

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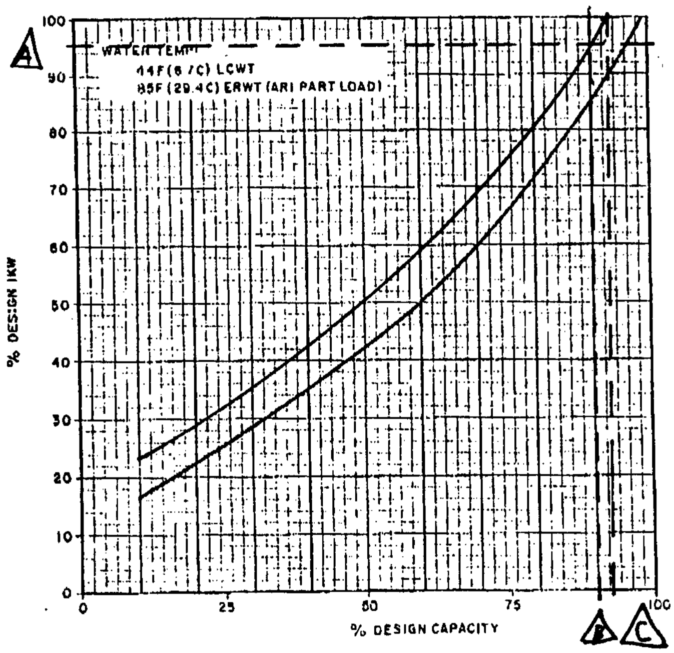
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 5900
Chiller No.: 1
Chiller Mfg.: CARRIER

Design Rating:
Tons: 400 MBtu: 4800
Amps: 476 Volts: 460

Test Reading:
kW: 324 Tons: 359.7
PF: 89.5

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000}$ = $\frac{\sqrt{3} \times 460 \times 476 \times .895}{1000}$

= 339.4 kW

Tested kW Input = 324 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{324}{339.4}$ = 95.5 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{359.7}{400}$ = 90 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :

92.5 % X Rated Tons = .925X400

= 370 Tons; or 4440 MBtu

Max. Output MBtu: 4440 MBtu
Max. kW Input: 339.4 kW

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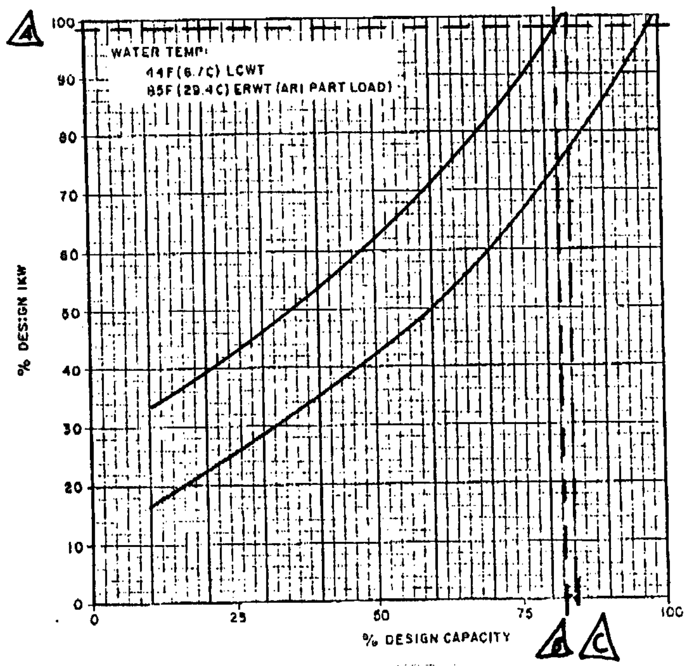
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 5900
Chiller No.: 2
Chiller Mfg.: WESTINGHOUSE

Design Rating:

Tons: 400 MBtu: 4800
Amps: 438 Volts: 460

Test Reading:

kW: 309 Tons: 327.7
PF: 90.6

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000}$ = $\frac{\sqrt{3} \times 460 \times 438 \times .906}{1000}$

= 316.2 kW

Tested kW Input = 309 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{309}{316.2}$ = 97.7 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{327.7}{400}$ = 82 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :

84 % X Rated Tons = .84 x 400
= 336 Tons; or 4032 MBtu

Max. Output MBtu:	4032	MBtu
Max. kW Input:	316.2	kW

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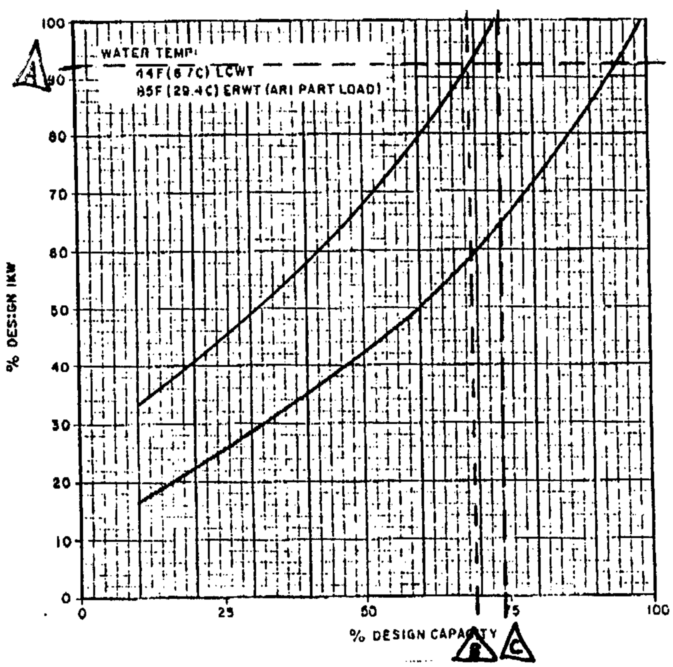
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 5900
Chiller No.: 3
Chiller Mfg.: CARRIER

Design Rating:
Tons: 400 MBtu: 4800
Amps: 346 Volts: 480

Test Reading:
kW: 230.8 Tons: 277.84
PF: 87.3

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000}$ = $\frac{\sqrt{3} \times 480 \times 346 \times 87.3\%}{1000}$

= 251.13 kW

Tested kW Input = 230.8 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{230.8}{251.13}$ = 92 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{277.84}{400}$ = 69.5 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :
74 % X Rated Tons = .74 x 400
= 296 Tons; or 3552 MBtu

Max. Output MBtu:	3552	MBtu
Max. kW Input:	251.13	kW

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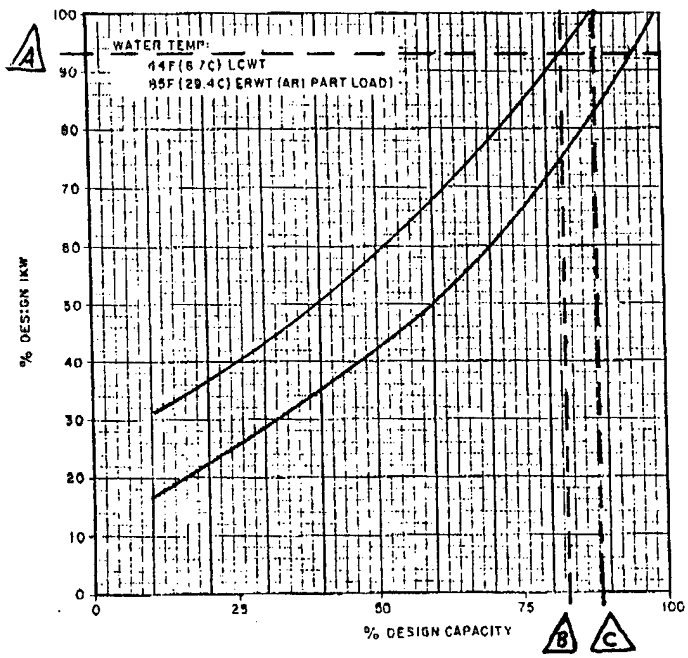
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 5900
Chiller No.: 4
Chiller Mfg.: MCQUAY

Design Rating:
Tons: 450 MBtu: 4800
Amps: 501 Volts: 480

Test Reading:
kW: 344.7 Tons: 374
PF: 89

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000}$ = $\frac{\sqrt{3} \times 480 \times 501 \times .89}{1000}$

= 370.7 kW

Tested kW Input = 344.7 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{344.7}{370.7}$ = 93 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{374}{450}$ = 83 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :

88 % X Rated Tons = .88 X 450
= 396 Tons; or 4752 MBtu

Max. Output MBtu:	4752	MBtu
Max. kW Input:	370.7	kW

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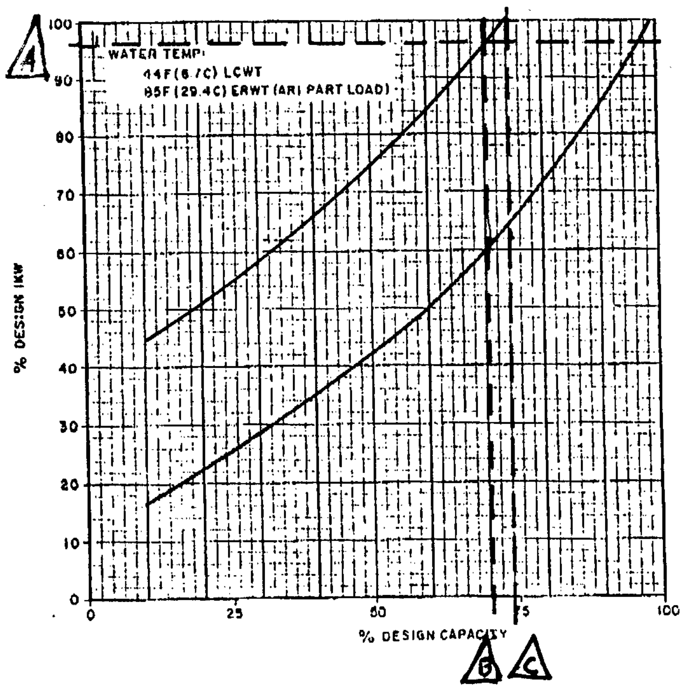
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 5900
Chiller No.: 5
Chiller Mfg.: CARRIER

Design Rating:

Tons: 400 MBtu: 4800
Amps: 390 Volts: 460

Test Reading:

kW: 238 Tons: 281
PF: 80

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000}$ = $\frac{\sqrt{3} \times 460 \times 390 \times .8}{1000}$

= 248.6 kW

Tested kW Input = 238 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{238}{248.6}$ = 96 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{281}{400}$ = 70 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :

73 % X Rated Tons = .73 x 400
= 292 Tons; or 3504 MBtu

Max. Output MBtu:	3504	MBtu
Max. kW Input:	248.6	kW

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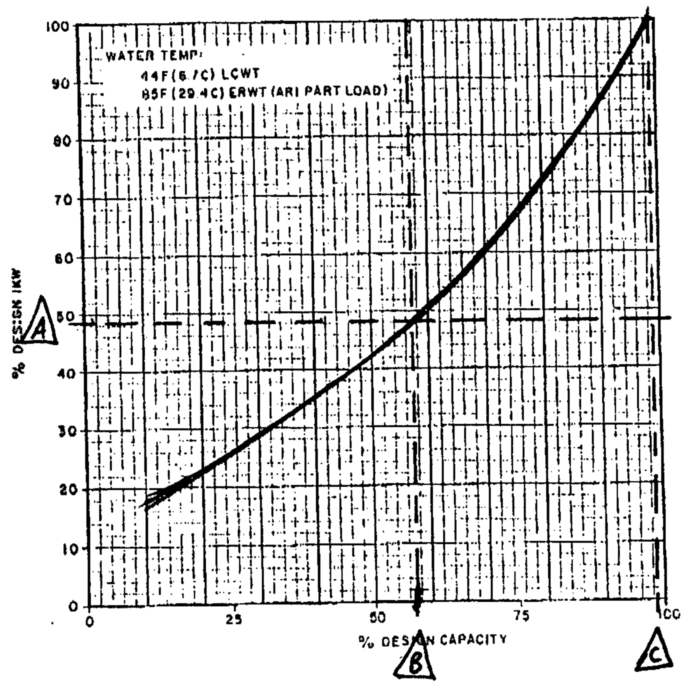
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 6003
Chiller No.: 2
Chiller Mfg.: TRANE

Design Rating:

Tons: 450 MBtu: 5400
Amps: 445 Volts: 460

Test Reading:

kW: 136 Tons: 256.5
PF: 80

Calculations:

Rated kW Input = $\frac{\sqrt{3} \text{ X Volt X Rated Amps X PF}}{1000}$ = $\frac{\sqrt{3} \times 460 \times 445 \times .8}{1000}$

= 284 kW

Tested kW Input = 136 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{136}{284}$ = 48 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{256.5}{450}$ = 57 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C):

99 % X Rated Tons = .99 x 450
= 445 Tons; or 5346 MBtu

Max. Output MBtu:	5346	MBtu
Max. kW Input:	284	kW

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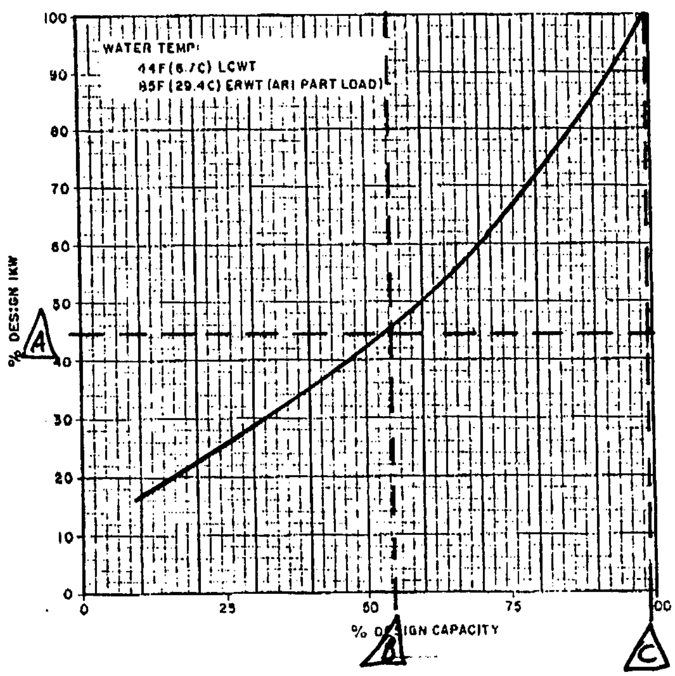
CHILLER OUTPUT CALCULATIONS

TYPICAL PART LOAD PERFORMANCE CURVE



Building No.: 6003
Chiller No.: 3
Chiller Mfg.: TRANE

Design Rating:
Tons: 450 MBtu: 5400
Amps: 445 Volts: 460

Test Reading:
kW: 125 Tons: 247.5
PF: 80

Calculations:

Rated kW Input = $\frac{\sqrt{3} \times \text{Volt} \times \text{Rated Amps} \times \text{PF}}{1000}$ = $\frac{\sqrt{3} \times 460 \times 445 \times .8}{1000}$

= 283.6 kW

Tested kW Input = 125 kW

From Graph:

% Design kW (A) = $\frac{\text{Tested kW Input}}{\text{Rated kW Input}}$ = $\frac{125}{283.6}$ = 44.1 %

% Design Capacity (B) = $\frac{\text{Tested Tons}}{\text{Rated Tons}}$ = $\frac{247.5}{450}$ = 55 %

The part load performance curve is shifted to meet testing conditions, the maximum chiller capacity is (C) :

99 % X Rated Tons = .99 X 450
= 445 Tons; or 5346 MBtu

Max. Output MBtu: 5346 MBtu
Max. kW Input: 283.6 kW

APPENDIX C.2

BOILERS EFFICIENCY CALCULATIONS

BOILER COMBUSTION TESTED EFFICIENCY AND CAPACITY

BOILER TESTED CAPACITY

CENTRAL PLANT	BOILER NO.	BOILER TYPE	BOILER MANUFACTURERER	RATED BOILER OUTPUT MMBTU/H	CALC. BOILER OUTPUT MMBTU/H	RATED BOILER INPUT MMBTU/H	LOW FIRE O2 (%)	LOW FIRE CO ppm/%	LOW FIRE STACK TEMP (°F)	LOW FIRE BOILER EFF (%)	50% FIRE O2 (%)	50% FIRE CO ppm/%	50% FIRE STACK TEMP (°F)	50% FIRE BOILER EFF (%)
5900	1	HTHW	INTERNATIONAL	10.00	6.94	12.50	6.1	10	558	76.30%	5.9	17	595	75.20%
	2	HTHW	INTERNATIONAL	10.00	7.17	12.50	6.6	15	500	77.50%	1.4	25	590	78.00%
	3	HTHW	HERCULES	9.70	7.61	12.13	10.9	3	303	80.70%	5.2	11	400	81.20%
	4	HTHW	HERCULES	9.70	7.58	12.13	12.6	2.95%	231	82.40%	6.4	0.8%	400	80.50%
	5	HTHW	INTERNATIONAL	8.00	6.22	10.00	9.5	55	350	80.30%	8.2	24	410	79.10%
	6	HTHW	INTERNATIONAL	11.20	8.88	14.00	8.4	0	371	80.00%	8	0	360	80.70%
6003	1	STEAM-12	KEWANEE	11.72	9.41	14.65	15.2	0	271	77.20%	7.1	0	322	82.40%
	2	STEAM-12	YORK SHIPLEY	11.72	9.12	14.65	10.4	47	250	82.90%	13	575	263	80.60%
	3	STEAM-12	KEWANEE	11.72	9.37	14.65	14.2	293	240	80.40%	8.6	21	295	82.60%
730	1	STEAM-12	KEWANEE	7.75	6.16	9.69	4	0	185	86.00%	SOOTING PROBLEM, CANNOT TESTED			
	2	STEAM-12	KEWANEE	7.75	6.16	9.69	4	0	192	86.00%	3	0	295	81.50%
	3	STEAM-12	KEWANEE	7.75	6.18	9.69	0.3	0	265	85.60%	5.5	0.35%	345	82.40%
	4	STEAM-12	KEWANEE	2.66	2.11	3.32	12.5	0	222	85.00%				
2812	1	STEAM-12	FEDERAL BOILER CO	1.80	1.40	2.25								
	2	HW	THERMO-PAK BOILER INC.	3.95	2.77	4.94	13.3	0	429	72.00%				
	3	HW	THERMO-PAK BOILER INC.	3.95	2.86	4.94	14.3	0	375	72.40%				
5676	1	HW	AMERICAN STANDARD	2.44	1.80	3.05	15	0	308	74.00%				
	2	HW	AMERICAN STANDARD	2.44	1.71	3.05	11.8	0	453	72.90%				
5678	1	HW	BRUNHAM	2.27	1.50	2.84	17	0.132%	310	74.10%				
	2	HW	BRUNHAM	2.27	1.63	2.84	15.5	0.132%	286	76.60%				
914	1	STEAM-12	BRUNHAM	1.61	1.29	2.01	7.3	9	359	80.90%				
	2	HW	RAY-PAK	1.61	1.22	2.01								
	3	HW	AMERICAN STANDARD	1.92	1.47	2.40								
	4	HW	AMERICAN STANDARD	1.92	1.40	2.40								
4701	1	STEAM-100	BIRCHFIELD	11.00	8.43	13.75	5.2	20	434	80.30%	4.2	30	475	78.90%
	2	STEAM-100	BIRCHFIELD	11.00	0.00	13.75								
	3	STEAM-100	BIRCHFIELD	11.00	8.43	13.75	8.3	19	418	78.70%	3.9	37	457	79.50%

[BOILERS.WK3]

BOILER TESTED CAPACITY

CENTRAL PLANT	BOILER NO.	BOILER TYPE	BOILER MANUFACTURERER	RATED BOILER OUTPUT MMBTU/H	CALC. BOILER OUTPUT MMBTU/H	RATED BOILER INPUT MMBTU/H	75% FIRE O2 (%)	75% FIRE CO ppm/%	75% FIRE STACK TEMP (°F)	75% FIRE BOILER EFF (%)	100% FIRE (HIGH FIRE) O2 (%)	100% FIRE (HIGH FIRE) CO ppm/%	100% FIRE (HIGH FIRE) STACK TEMP (°F)	100% FIRE (HIGH FIRE) BOILER EFF (%)
5900	1	HTHW	INTERNATIONAL	10.00	6.94	12.50	5.6	14	660	73.70%	7	14	702	70.90%
	2	HTHW	INTERNATIONAL	10.00	7.17	12.50					5	42	690	73.20%
	3	HTHW	HERCULES	9.70	7.61	12.13	4.6	17	414	81.00%	5.5	25	434	80.00%
	4	HTHW	HERCULES	9.70	7.58	12.13	4.7	0.2%	418	81.00%	5.9	10%	440	79.60%
	5	HTHW	INTERNATIONAL	8.00	6.22	10.00	6.9	16	440	79.00%	5.6	17	465	79.20%
	6	HTHW	INTERNATIONAL	11.20	8.88	14.00	6.9	0	389	80.60%	5.4	0	402	80.80%
6003	1	STEAM-12	KEWANEE	11.72	9.41	14.65	6.4	0	335	82.30%	6.6	0	337	82.30%
	2	STEAM-12	YORK SHIPLEY	11.72	9.12	14.65	12.7	280	290	80.00%	11.9	200	303	79.80%
	3	STEAM-12	KEWANEE	11.72	9.37	14.65	10	21	310	81.90%				81.90%
730	1	STEAM-12	KEWANEE	7.75	6.16	9.69								
	2	STEAM-12	KEWANEE	7.75	6.16	9.69	0.4	1.5%	416	82.40%	2.7	0.2%	421	81.40%
	3	STEAM-12	KEWANEE	7.75	6.18	9.69	5.6	0.2%	358	82.00%	5.8	0.12%	362	81.70%
	4	STEAM-12	KEWANEE	2.66	2.11	3.32					6.3	0	371	81.50%
2812	1	STEAM-12	FEDERAL BOILER CO	1.80	1.40	2.25					8.7	0	380	79.70%
	2	HW	THERMO-PAK BOILER INC.	3.95	2.77	4.94					13.1	0	429	71.50%
	3	HW	THERMO-PAK BOILER INC.	3.95	2.86	4.94					10.8	0	472	74.00%
5676	1	HW	AMERICAN STANDARD	2.44	1.80	3.05					4.6	9.2%	607	75.10%
	2	HW	AMERICAN STANDARD	2.44	1.71	3.05					5	0.02	740	71.40%
5678	1	HW	BRUNHAM	2.27	1.50	2.84					15.4	0.232%	430	67.50%
	2	HW	BRUNHAM	2.27	1.63	2.84					12	760	454	73.30%
914	1	STEAM-12	BRUNHAM	1.61	1.29	2.01					3.9	4	387	82.00%
	2	HW	RAY-PAK	1.61	1.22	2.01					8.4	14	454	77.40%
	3	HW	AMERICAN STANDARD	1.92	1.47	2.40					5.9	26	500	77.90%
	4	HW	AMERICAN STANDARD	1.92	1.40	2.40					11.1	0	460	74.40%
4701	1	STEAM-100	BIRCHFIELD	11.00	8.43	13.75	4.9	28	481	78.90%	4.7	31	486	79.20%
	2	STEAM-100	BIRCHFIELD	11.00	0.00	13.75								
	3	STEAM-100	BIRCHFIELD	11.00	8.43	13.75	4.8	37	470	79.50%	5.2	35	474	79.20%

[BOILERS.WK3]

BOILER STANDBY LOSS CALCULATION

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

JOB FT. SILL C. PLANT, EMC #3002.00C

SHEET NO. ______ OF ______

CALCULATED BY CEL DATE 3/11/91

CHECKED BY ______ DATE ______

SCALE ______

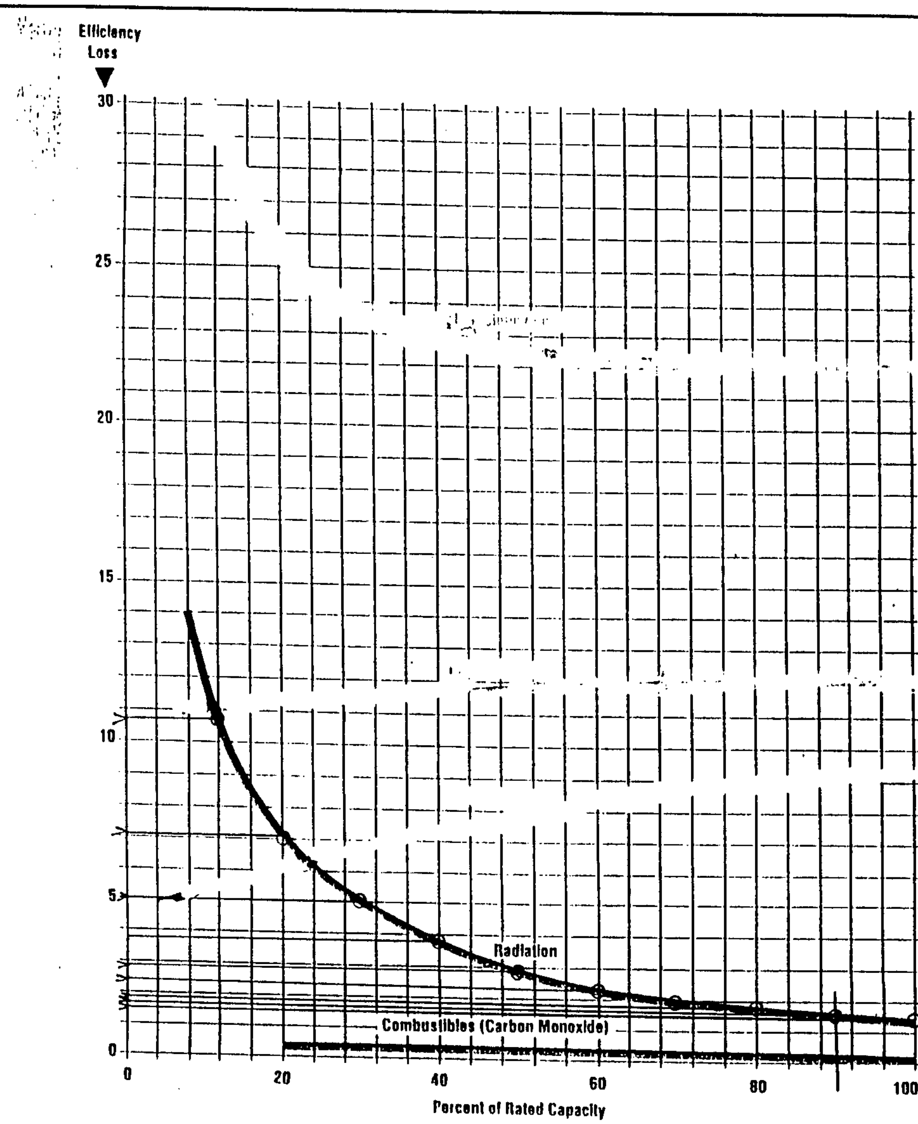


Fig. 42 Effect of Boiler Capacity on Various Losses — FROM "IMPROVING BOILER EFFICIENCY", K.S. UNIV.

BOILER RADIATION (STANDBY) LOSSES

PERCENT OF CAPACITY (%)	EFFICIENCY LOSS (%)
10	10.7
20	7.1
30	5.0
40	3.8
50	2.9
60	2.4
70	1.9
80	1.65
90	1.55
100	1.5

BOILER BLOWDOWN LOSS CALCULATION

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

JOB FT. SILL C. PLANT, EMC 3002.000

SHEET NO. ____ OF ____

CALCULATED BY CEL DATE 3/11/91

CHECKED BY ____ DATE ____

SCALE ____

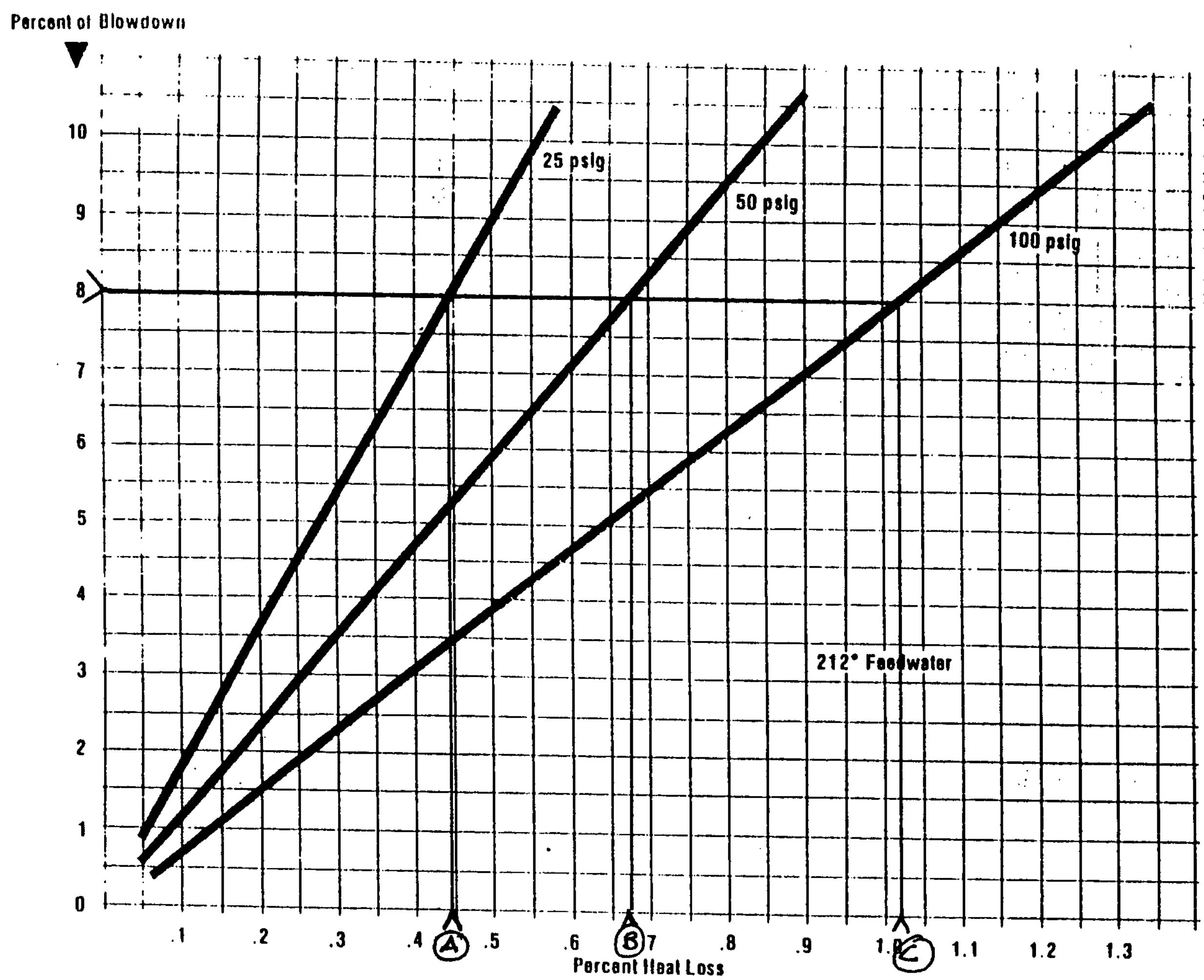


Fig. 37 Effect of Boiler Pressure and % Blowdown on Blowdown Heat Loss

BASED ON 8% BLOWDOWN

A 25 PSIG — .44% HEAT LOSS

B 50 PSIG — .67% " "

C 100 PSIG — 1.02% " "

SOURCE: "IMPROVING BOILER EFFICIENCY", KANSAS STATE UNIVERSITY

BOILER COMBUSTION TESTED EFFICIENCY AND CAPACITY
INCLUDED STANDBY AND BLOWDOWN LOSSES

BOILER CAPACITY AND TEST RESULTS

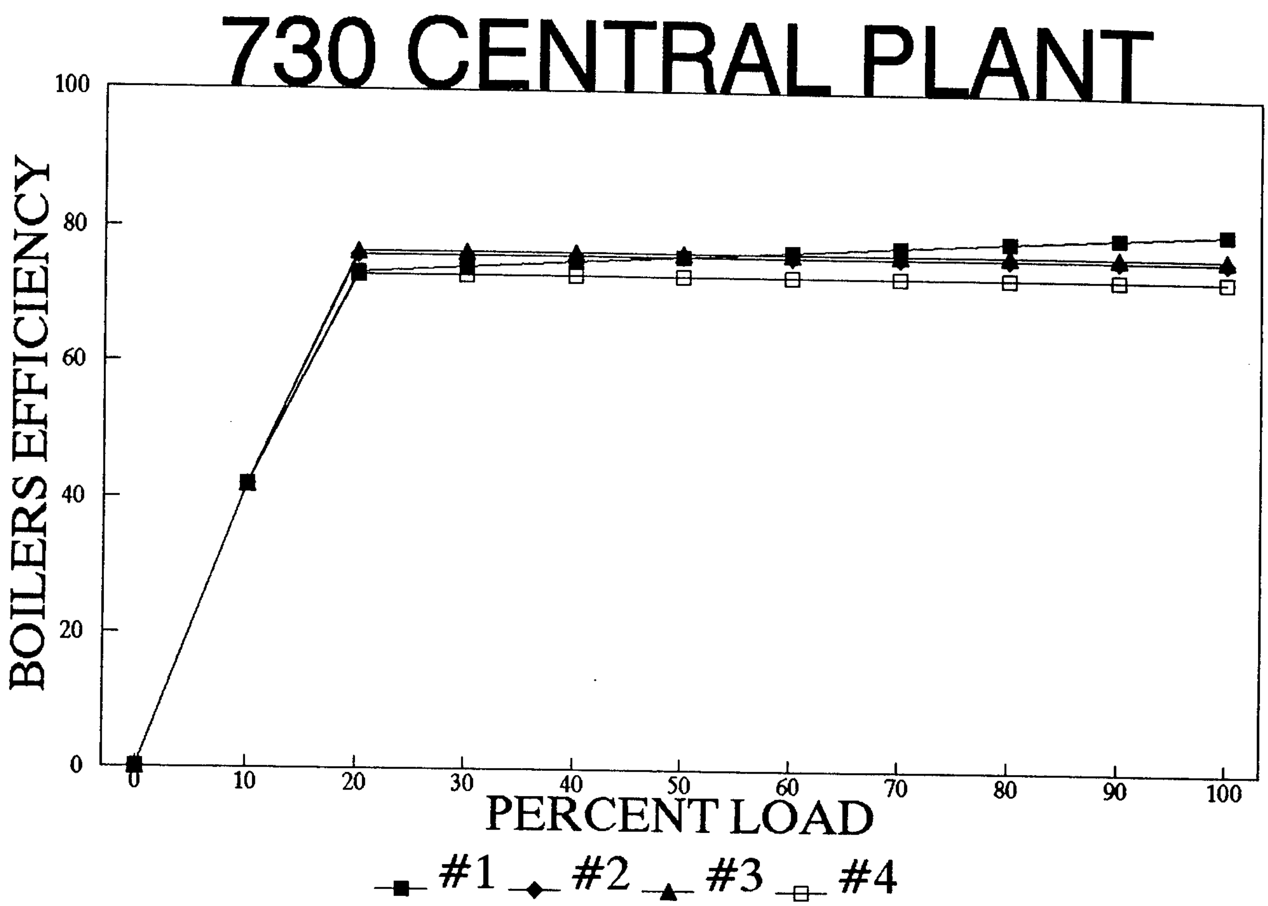
[BOILERS.WK3]

BLOWDOWN LOSSES			
		25 PSIG	0.44%
		50 PSIG	0.67%
		100 PSIG	1.02%

STANDBY LOSSES	10.70%	7.10%	2.90%	1.90%	1.50%

BLDG NUMB	NUMBER OF BOILER	BOILER TYPE	BOILER MANUFACTURERER	BOILER OUTPUT MBTU/H	BOILER OUTPUT MBTU/H	LOWFIRE TESTED	LOWFIRE W/LOSSES	50% FIRE TESTED	50% FIRE W/LOSSES	75% FIRE TESTED	75% FIRE W/LOSSES	HIGHFIRE TESTED	HIGHFIRE W/LOSSES
5900	1	HTHW	INTERNATIONAL	6.94	12.50	76.30%	69.20	75.20%	72.30	73.70%	71.80	70.90%	69.40
	2	HTHW	INTERNATIONAL	7.17	12.50	77.50%	70.40	78.00%	75.10			73.20%	71.70
	3	HTHW	HERCULES	7.61	12.13	80.70%	73.60	81.20%	78.30	81.00%	79.10	80.00%	78.50
	4	HTHW	HERCULES	7.58	12.13	82.40%	75.30	80.50%	77.60	81.00%	79.10	79.60%	78.10
	5	HTHW	INTERNATIONAL	6.22	10.00	80.30%	73.20	79.10%	76.20	79.00%	77.10	79.20%	77.70
	6	HTHW	INTERNATIONAL	8.88	14.00	80.00%	72.90	80.70%	77.80	80.60%	78.70	80.80%	79.30
6003	1	STEAM-12	KEWANEE	9.41	14.65	77.20%	69.66	82.40%	79.06	82.30%	79.96	82.30%	80.36
	2	STEAM-12	YORK SHIPLEY	9.12	14.65	82.90%	75.36	80.60%	77.26	80.00%	77.66	79.80%	77.86
	3	STEAM-12	KEWANEE	9.37	14.65	80.40%	72.86	82.60%	79.26	81.90%	79.56	81.90%	79.96
730	1	STEAM-12	KEWANEE	6.16	9.69	86.00%	78.46						
	2	STEAM-12	KEWANEE	6.16	9.69	86.00%	78.46	81.50%	78.16	82.40%	80.06	81.40%	79.46
	3	STEAM-12	KEWANEE	6.18	9.69	85.60%	78.06	82.40%	79.06	82.00%	79.66	81.70%	79.76
	4	STEAM-12	KEWANEE	2.11	3.32	85.00%	77.46					81.50%	79.56
2812	1	STEAM-12	FEDERAL BOILER CO	1.40	2.25							79.70%	77.76
	2	HW	THERMO-PAK BOILER INC.	2.77	4.94	72.00%	64.90					71.50%	70.00
	3	HW	THERMO-PAK BOILER INC.	2.86	4.94	72.40%	65.30					74.00%	72.50
5676	1	HW	AMERICAN STANDARD	1.80	3.05	74.00%	66.90					75.10%	73.60
	2	HW	AMERICAN STANDARD	1.71	3.05	72.90%	65.80					71.40%	69.90
5678	1	HW	BRUNHAM	1.50	2.84	74.10%	67.00					67.50%	66.00
	2	HW	BRUNHAM	1.63	2.84	76.60%	69.50					73.30%	71.80
914	1	STEAM-12	BRUNHAM	1.29	2.01	80.90%	73.36					82.00%	80.06
	2	HW	RAY-PAK	1.22	2.01							77.40%	75.90
	3	HW	AMERICAN STANDARD	1.47	2.40							77.90%	76.40
	4	HW	AMERICAN STANDARD	1.40	2.40							74.40%	72.90
4701	1	STEAM-100	BIRCHFIELD	8.43	13.75	80.30%	72.18	78.90%	74.98	78.90%	75.98	79.20%	76.68
	2	STEAM-100	BIRCHFIELD	0.00	13.75								
	3	STEAM-100	BIRCHFIELD	8.43	13.75	78.70%	70.58	79.50%	75.58	79.50%	76.58	79.20%	76.68

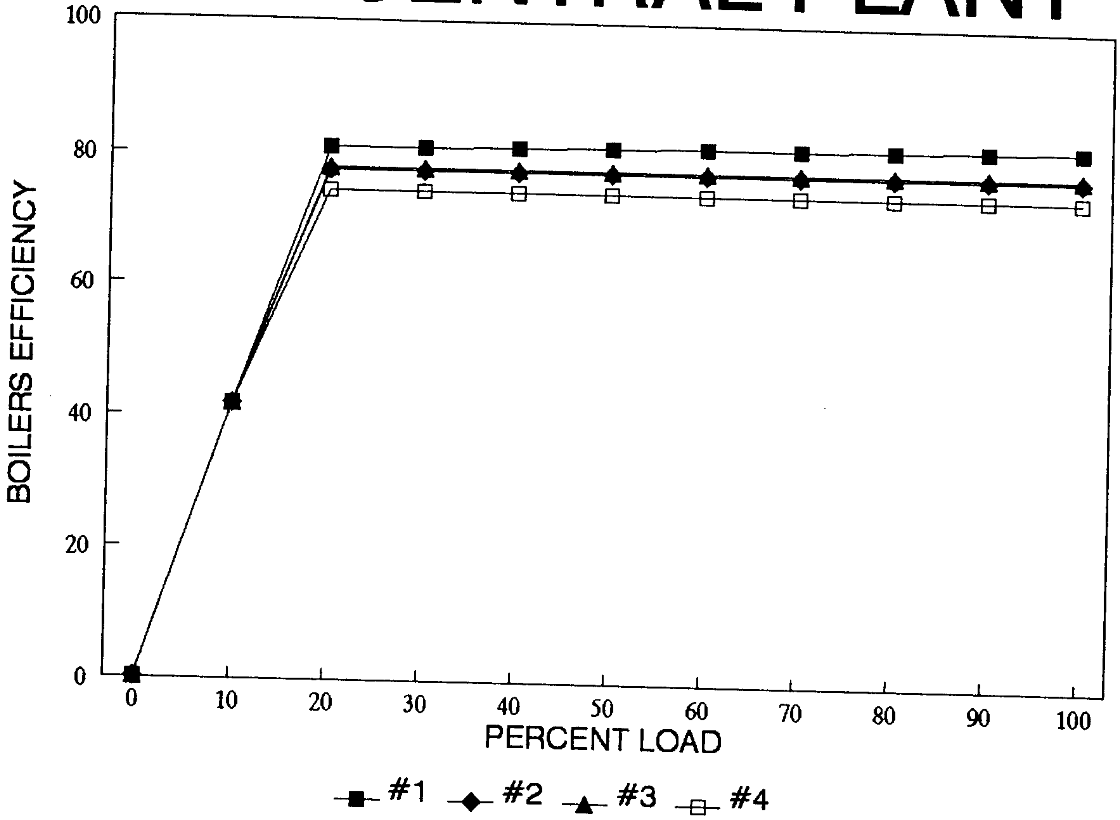
BLDG. NUMBER	NUMBER OF BOILER	BOILER MANUFACTURERER	BOILER MODEL NUMBER	PERCENT LOAD	BOILERS TESTING EFF.	PERCENT MAX. ENERGY INPUT
730	1	KEWANEE	CAT#7L286-KX	0	0.2	0.0
				10	42	0.0
13-Mar-91				20	78.5	0.0
08:28:00 AM				30	52.3	0.0
				40	26.2	0.0
				50	0.0	ERR
				60	0.0	ERR
				70	0.0	ERR
				80	0.0	ERR
				90	0.0	ERR
				100	0.0	ERR
	2	KEWANEE	CAT#7L286-KX	0	0.2	0.0
				10	42.0	18.9
				20	78.5	20.3
				30	78.4	30.4
				40	78.3	40.6
				50	78.2	50.8
				60	78.4	60.8
				70	80.1	69.5
				80	80.3	79.1
				90	80.6	88.7
				100	79.5	100.0
	3	KEWANEE	CAT#7L286-KX	0	0.2	0.0
				10	42	19.0
				20	78.1	20.4
				30	78.4	30.5
				40	78.7	40.5
				50	79.1	50.4
				60	79.2	60.4
				70	79.7	70.1
				80	79.8	80.0
				90	79.9	89.8
				100	79.8	100.0
	4	KEWANEE	CAT#7L280-KG-	0	0.2	0.0
				10	42	18.9
				20	77.5	20.5
				30	77.7	30.7
				40	78.0	40.8
				50	78.2	50.8
				60	78.5	60.8
				70	78.8	70.7
				80	79.0	80.5
				90	79.3	90.3
				100	79.6	100.0



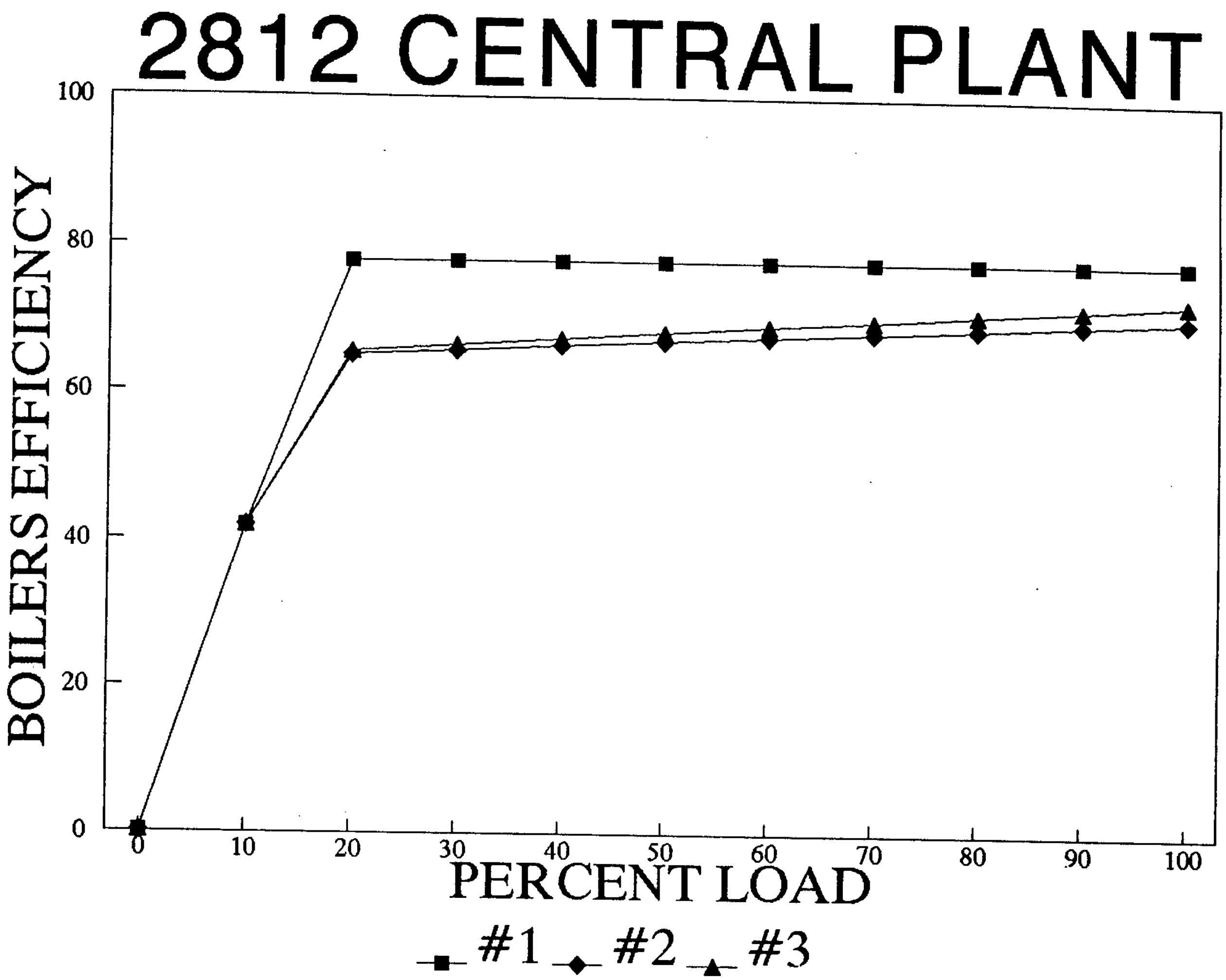
730 CENTRAL PLANT
BOILERS EFFICIENCY
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
90
100
PERCENT LOAD
#1
#2
#3
#4

BLDG. NUMBER	NUMBER OF BOILER	BOILER MANUFACTURERER	BOILER MODEL NUMBER	PERCENT LOAD	BOILERS TESTING EFF.	PERCENT MAX. ENERGY INPUT
914 13–Mar–91 08:28:00 AM	1	BRUNHAM	PF510	0	0.2	0.0
				10	42	19.1
				20	73.4	21.8
				30	74.2	32.4
				40	75.0	42.7
				50	75.9	52.8
				60	76.7	62.6
				70	77.5	72.3
				80	78.4	81.7
				90	79.2	91.0
				100	80.1	100.0
	2	RAY–PAK	EA 200ITB	0	0.2	0.0
				10	42	18.1
				20	75.9	20.0
				30	75.9	30.0
				40	75.9	40.0
				50	75.9	50.0
				60	75.9	60.0
				70	75.9	70.0
				80	75.9	80.0
				90	75.9	90.0
				100	75.9	100.0
	3	AMERICAN STD	G1015	0	0.2	0.0
				10	42	18.2
				20	76.4	20.0
				30	76.4	30.0
				40	76.4	40.0
				50	76.4	50.0
				60	76.4	60.0
				70	76.4	70.0
				80	76.4	80.0
				90	76.4	90.0
				100	76.4	100.0
	4	AMERICAN STD	G1015	0	0.2	0.0
				10	42	17.4
				20	72.9	20.0
				30	72.9	30.0
				40	72.9	40.0
				50	72.9	50.0
				60	72.9	60.0
				70	72.9	70.0
				80	72.9	80.0
				90	72.9	90.0
				100	72.9	100.0

914 CENTRAL PLANT

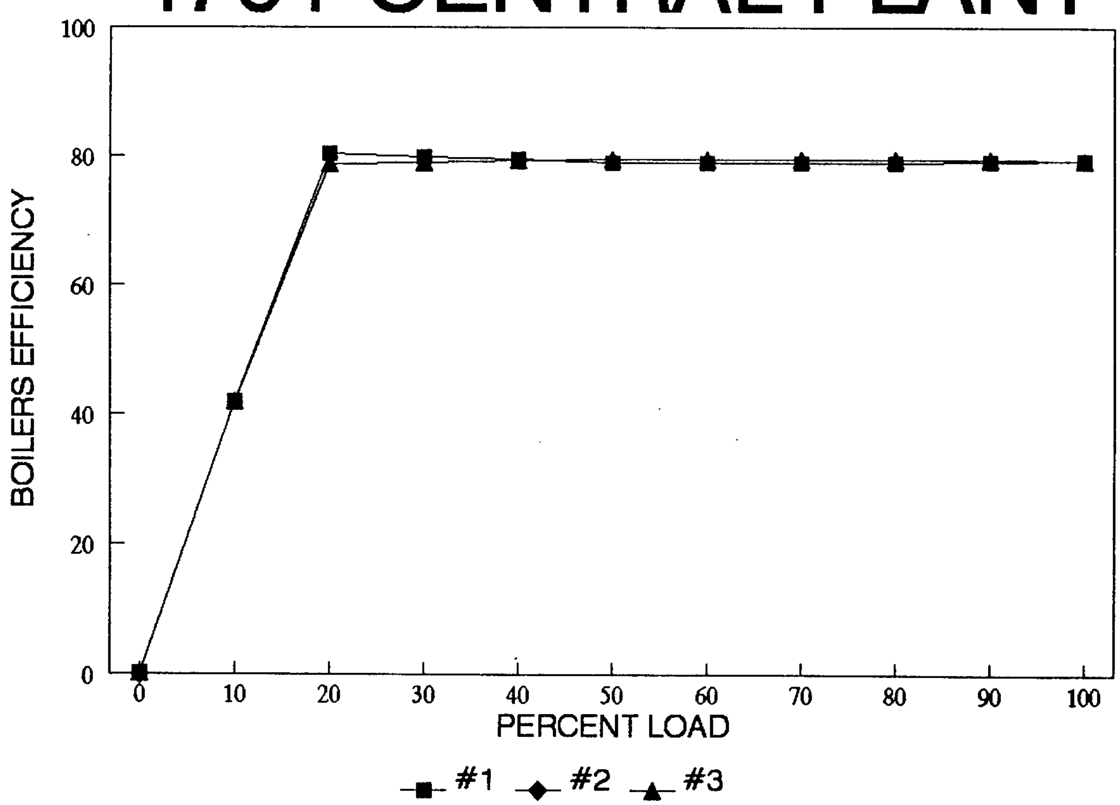


BLDG. NUMBER	NUMBER OF BOILER	BOILER MANUFACTURERER	BOILER MODEL NUMBER	PERCENT LOAD	BOILERS TESTING EFF.	PERCENT MAX. ENERGY INPUT
2812 13-Mar-91 08:28:00 AM	1	FEDERAL BOILER CO	GS 3562	0	0.2	0.0
				10	42	18.5
				20	77.8	20.0
				30	77.8	30.0
				40	77.8	40.0
				50	77.8	50.0
				60	77.8	60.0
				70	77.8	70.0
				80	77.8	80.0
				90	77.8	90.0
				100	77.8	100.0
	2	THERMO-PAK BOILER	GW 5500X	0	0.2	0.0
				10	42	16.7
				20	64.9	21.6
				30	65.5	32.0
				40	66.2	42.3
				50	66.8	52.4
				60	67.5	62.3
				70	68.1	72.0
				80	68.7	81.5
				90	69.4	90.8
				100	70.0	100.0
	4	KEWANEE	CAT#7L280-KG-	0	0.2	0.0
				10	42	17.3
				20	65.3	22.2
				30	66.2	32.9
				40	67.1	43.2
				50	68.0	53.3
				60	68.9	63.1
				70	69.8	72.7
				80	70.7	82.0
				90	71.6	91.1
				100	72.5	100.0


2812 CENTRAL PLANT
BOILERS EFFICIENCY
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
90
100
PERCENT LOAD
#1
#2
#3

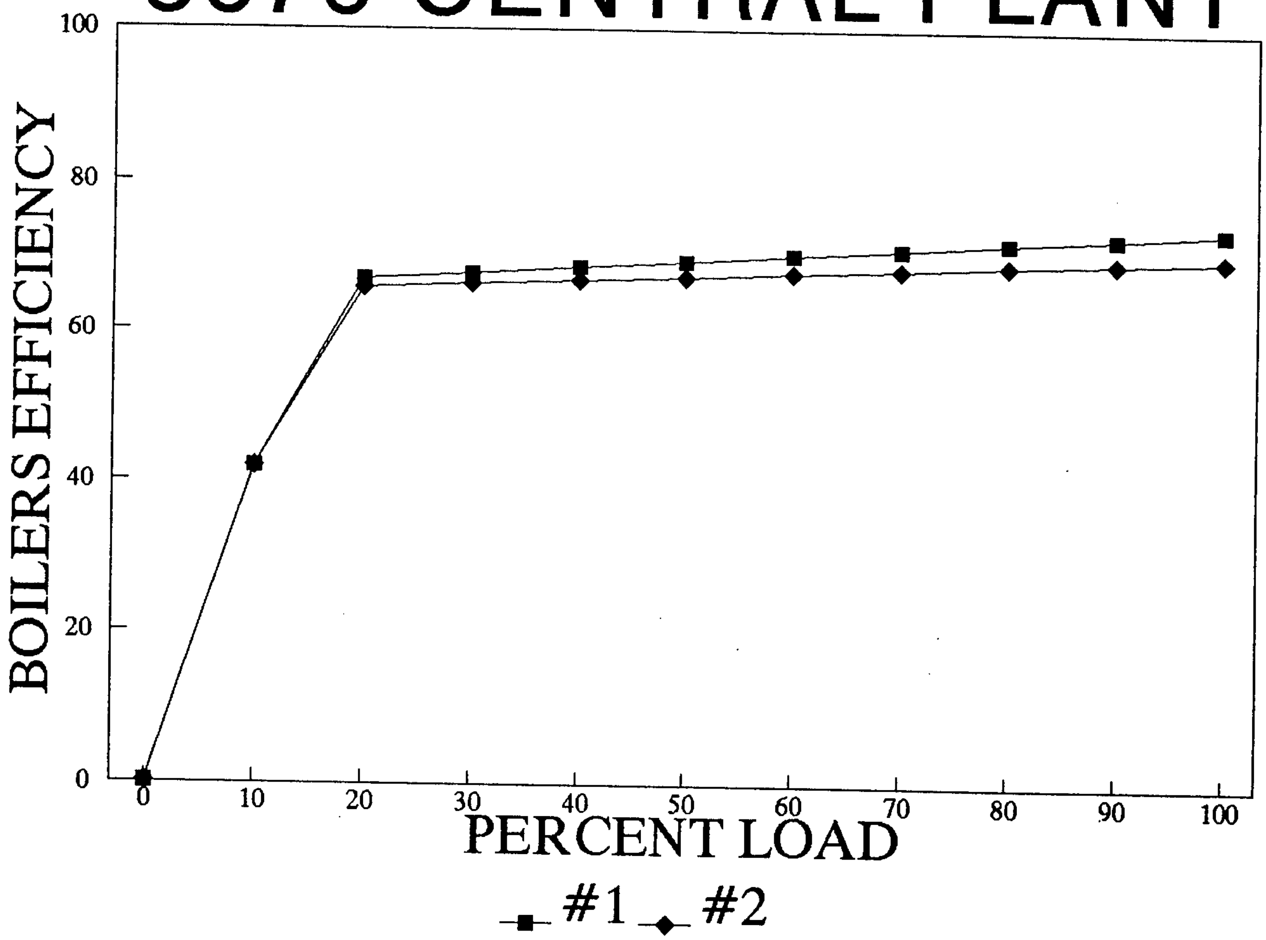
BLDG. NUMBER	NUMBER OF BOLER	BOILER MANUFACTURERER	BOILER MODEL NUMBER	PERCENT LOAD	BOILERS TESTING EFF.	PERCENT MAX. ENERGY INPUT
4701	1	BIRCHFIELD	FBH 578	0	0.2	0.0
				10	42	18.3
13-Mar-91				20	72.8	21.1
08:28:00 AM				30	73.5	31.3
				40	74.2	41.3
				50	75.0	51.1
				60	75.3	61.1
				70	76.0	70.6
				80	76.3	80.4
				90	76.7	90.0
				100	76.7	100.0
	2	BIRCHFIELD	FBH 578	0	0.2	0.0
				10	42	0.0
				20	0.0	ERR
				30	0.0	ERR
				40	0.0	ERR
				50	0.0	ERR
				60	0.0	ERR
				70	0.0	ERR
				80	0.0	ERR
				90	0.0	ERR
				100	0.0	ERR
	3	BIRCHFIELD	FBH 578	0	0.2	0.0
				10	42	18.3
				20	71.2	21.6
				30	72.6	31.7
				40	74.1	41.4
				50	75.6	50.7
				60	75.8	60.7
				70	76.6	70.1
				80	76.8	79.9
				90	77.0	89.6
				100	76.7	100.0

4701 CENTRAL PLANT



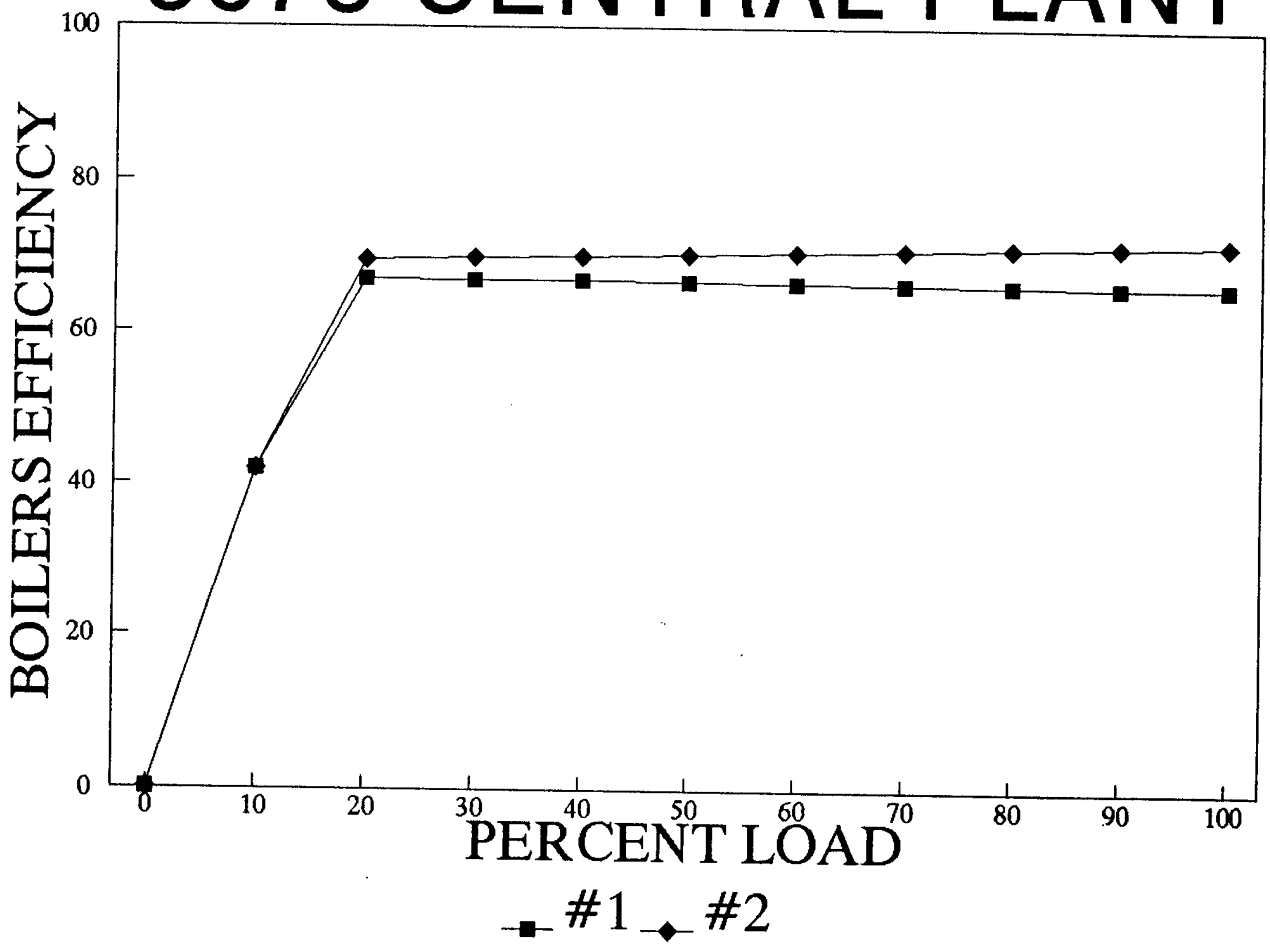
BLDG. NUMBER	NUMBER OF BOILER	BOILER MANUFACTURERER	BOILER MODEL NUMBER	PERCENT LOAD	BOILERS TESTING EFF.	PERCENT MAX. ENERGY INPUT
5676 13–Mar–91 08:28:00 AM	1	AMERICAN STANDARD	PF515	0	0.2	0.0
				10	42	17.5
				20	66.9	22.0
				30	67.7	32.6
				40	68.6	42.9
				50	69.4	53.0
				60	70.3	62.9
				70	71.1	72.5
				80	71.9	81.9
				90	72.8	91.0
				100	73.6	100.0
	2	AMERICAN STANDARD	PF515	0	0.2	0.0
				10	42	16.6
				20	65.8	21.2
				30	66.3	31.6
				40	66.8	41.8
				50	67.3	51.9
				60	67.9	61.8
				70	68.4	71.6
				80	68.9	81.2
				90	69.4	90.7
				100	69.9	100.0

5676 CENTRAL PLANT



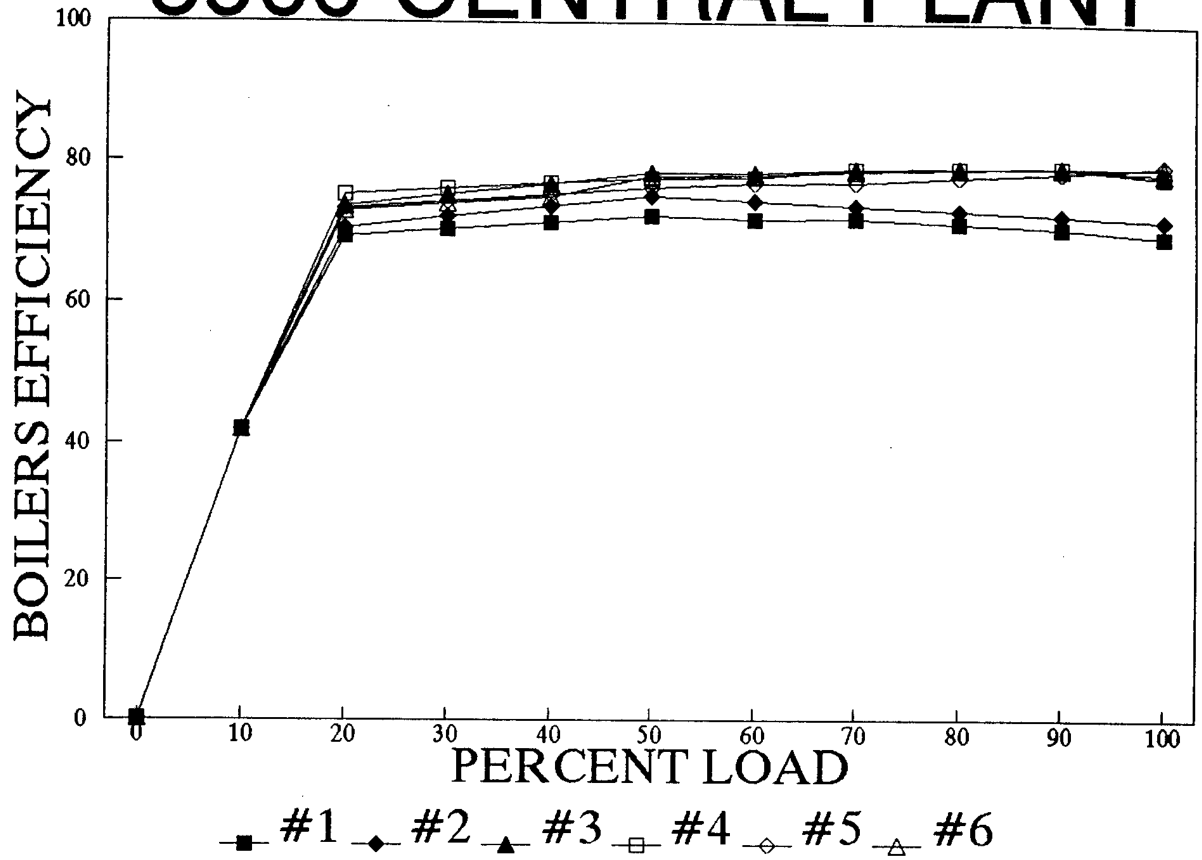
BLDG. NUMBER	NUMBER OF BOILER	BOILER MANUFACTURERER	BOILER MODEL NUMBER	PERCENT LOAD	BOILERS TESTING EFF.	PERCENT MAX. ENERGY INPUT
5678 13-Mar-91 08:28:00 AM	1	BRUNHAM	PF514	0	0.2	0.0
				10	42	15.7
				20	67.0	19.7
				30	66.9	29.6
				40	66.8	39.6
				50	66.6	49.5
				60	66.5	59.5
				70	66.4	69.6
				80	66.3	79.7
				90	66.1	89.8
				100	66.0	100.0
	2	BRUNHAM	PF514	0	0.2	0.0
				10	42	17.1
				20	69.5	20.7
				30	69.8	30.9
				40	70.1	41.0
				50	70.4	51.0
				60	70.6	61.0
				70	70.9	70.9
				80	71.2	80.6
				90	71.5	90.4
				100	71.8	100.0

5678 CENTRAL PLANT



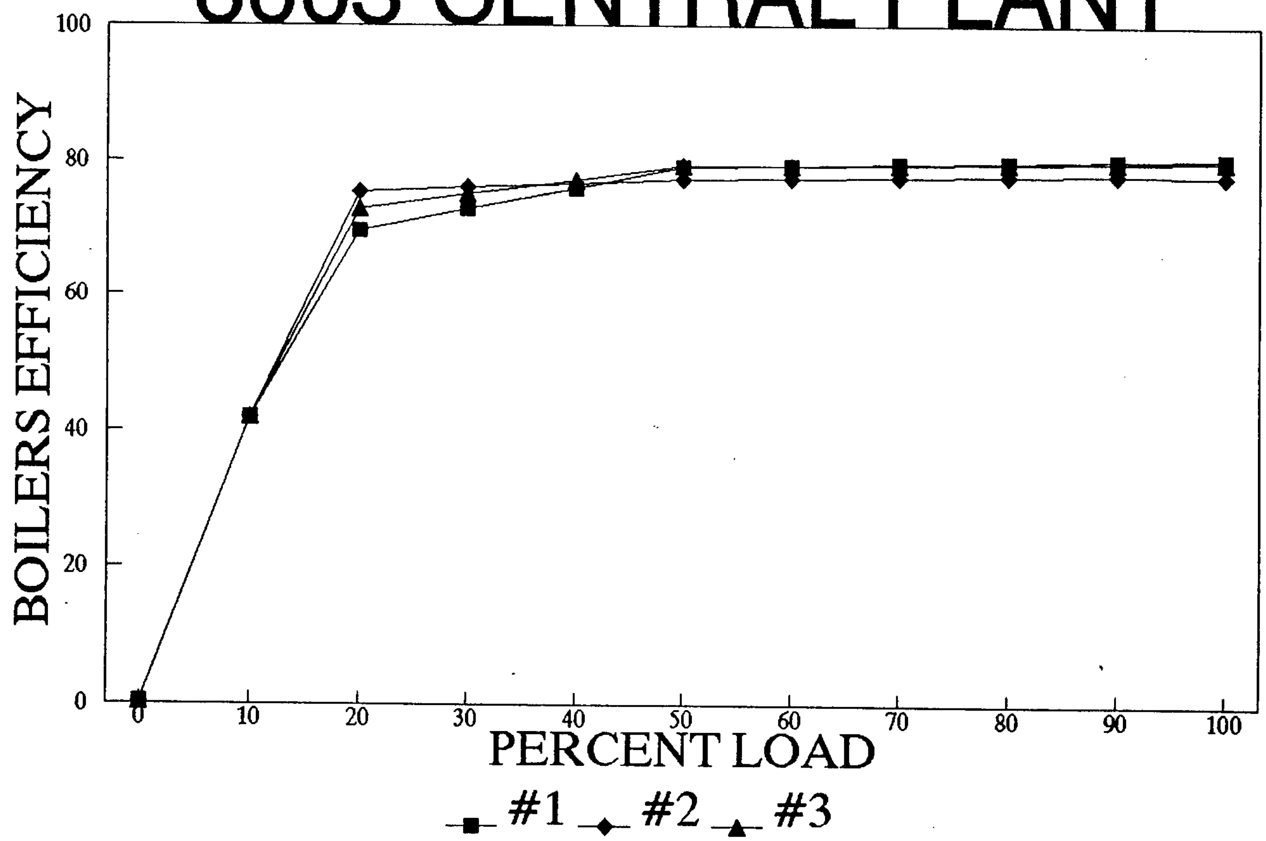
BLDG. NUMBER	NUMBER OF BOILER	BOILER MANUFACTURE	BOILER MODEL NUMBER	PERCENT LOAD	BOILERS TESTING EFF.	PERCENT MAX. ENERGY INPUT
5900	1	INTERNATIONAL	D-12	0	0.2	0.0
13-Mar-91				10	42	16.5
08:28:00 AM				20	69.2	20.1
				30	70.2	29.6
				40	71.3	39.0
				50	72.3	48.0
				60	71.7	58.1
				70	71.8	67.7
				80	71.2	78.0
				90	70.6	88.4
				100	69.4	100.0
	2	INTERNATIONAL	D-12	0	0.2	0.0
				10	42.0	17.1
				20	70.4	20.4
				30	72.0	29.9
				40	73.5	39.0
				50	75.1	47.7
				60	74.4	57.8
				70	73.7	68.1
				80	73.1	78.5
				90	72.4	89.2
				100	71.7	100.0
	3	HERCULES	300	0	0.2	0.0
				10	42	18.7
				20	73.6	21.3
				30	75.2	31.3
				40	76.7	40.9
				50	78.3	50.1
				60	78.3	60.1
				70	79.1	69.5
				80	79.1	79.4
				90	79.2	89.2
				100	78.5	100.0
	4	HERCULES	300	0	0.2	0.0
				10	42	18.6
				20	75.3	20.7
				30	76.1	30.8
				40	76.8	40.7
				50	77.6	50.3
				60	77.7	60.3
				70	79.1	69.1
				80	79.2	78.9
				90	79.3	88.6
				100	78.1	100.0
	5	INTERNATIONAL	1035 TH12	0	0.2	0.0
				10	42	19.0
				20	73.2	21.8
				30	74.2	32.2
				40	75.2	42.4
				50	76.2	52.3
				60	76.9	62.2
				70	77.1	72.4
				80	77.8	82.0
				90	78.5	91.4
				100	79.8	100.0
	6	INTERNATIONAL	TJW-C-10	0	0.2	0.0
				10	42	18.9
				20	72.9	21.8
				30	73.9	32.2
				40	74.9	42.4
				50	77.8	51.0
				60	78.1	60.9
				70	78.7	70.5
				80	79.0	80.3
				90	79.3	90.0
				100	79.3	100.0

5900 CENTRAL PLANT



BLDG. NUMBER	NUMBER OF BOILER	BOILER MANUFACTURERER	BOILER MODEL NUMBER	PERCENT LOAD	BOILERS TESTING EFF.	PERCENT MAX. ENERGY INPUT
6003	1	KEWANEE	L39-350-605	0	0.2	0.0
13-Mar-91				10	42	19.1
08:28:00 AM				20	69.7	23.1
				30	72.8	33.1
				40	75.9	42.3
				50	79.1	50.8
				60	79.3	60.8
				70	79.6	70.7
				80	79.8	80.5
				90	80.1	90.3
				100	80.4	100.0
	2	YORK SHIPLEY	SPL-350-N11208	0	0.2	0.0
				10	42.0	18.5
				20	75.4	20.7
				30	76.0	30.7
				40	76.6	40.6
				50	77.3	50.4
				60	77.4	60.4
				70	77.7	70.2
				80	77.8	80.1
				90	77.9	90.0
				100	77.9	100.0
	3	KEWANEE	L36-350-605	0	0.2	0.0
				10	42	19.0
				20	72.9	21.9
				30	75.0	32.0
				40	77.1	41.5
				50	79.3	50.4
				60	79.4	60.4
				70	79.6	70.4
				80	79.7	80.3
				90	79.8	90.1
				100	80.0	100.0

6003 CENTRAL PLANT



BOILER STANDBY LOSS SAVING CALCULATION

BOILER STANDBY SAVINGS

CENTRAL PLANT	BOILER NO.	BOILER TYPE	BOILER MANUFACTURERER	BOILER MODEL NUMBER	RATED BOILER OUTPUT MMBTU/H	CALC. BOILER OUTPUT MMBTU/H	STANDBY LOSS (1%) MMBTU/H	EXCESS STANDBY (HRS/YR)	EXCESS STANDBY MMBTU/H	EXCESS STANDBY SAVINGS ($)
5900	1	HTHW	INTERNATIONAL	D-12	10.00	6.94	0.0694	0		
	2	HTHW	INTERNATIONAL	D-12	10.00	7.17	0.0717	720	51.62	$150.74
	3	HTHW	HERCULES	300	9.70	7.61	0.0761	720	54.82	$160.09
	4	HTHW	HERCULES	300	9.70	7.58	0.0758	720	54.55	$159.27
	5	HTHW	INTERNATIONAL	1035 TH12	8.00	6.22	0.0622	0		
	6	HTHW	INTERNATIONAL	TJW-C-10	11.20	8.88	0.0888	0		
						TOTAL		2160	160.99	$470.10
6003	1	STEAM-12	KEWANEE	L39-350-605	11.72	9.41	0.0941	0		
	2	STEAM-12	YORK SHIPLEY	SPL-350-112080	11.72	9.12	0.0912	0		
	3	STEAM-12	KEWANEE	L36-350-605	11.72	9.37	0.0937	720	67.45	$196.96
						TOTAL		720	67.45	$196.96
730	1	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	0		
	2	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	720	44.34	$129.47
	3	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.18	0.0618	720	44.51	$129.96
	4	STEAM-12	KEWANEE	CAT#7L280-KG-06	2.66	2.11	0.0211	0		
						TOTAL		1440	88.84	$259.43
2812	1	STEAM-12	FEDERAL BOILER CO	GS 3562	1.80	1.40	0.0140	0		
	2	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.77	0.0277	0		
	3	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.86	0.0286	720	20.62	$60.21
						TOTAL		720	20.62	$60.21
5676	1	HW	AMERICAN STANDARD	PF 515	2.44	1.80	0.0180	720	12.93	$37.76
	2	HW	AMERICAN STANDARD	PF 515	2.44	1.71	0.0171	0		
						TOTAL		720	12.93	$37.76
5678	1	HW	BRUNHAM	PF 514	2.27	1.50	0.0150	720	10.79	$31.50
	2	HW	BRUNHAM	PF 514	2.27	1.63	0.0163	0		
						TOTAL		720	10.79	$31.50
914	1	STEAM-12	BRUNHAM	PF-510	1.61	1.29	0.0129	0		
	2	HW	RAY-PAK	EA 200ITB	1.61	1.22	0.0122	0		
	3	HW	AMERICAN STANDARD	G1015	1.92	1.47	0.0147	720	10.56	$30.84
	4	HW	AMERICAN STANDARD	G1015	1.92	1.40	0.0140	0		
						TOTAL		720	10.56	$30.84
4701	1	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	0		
	2	STEAM-100	BIRCHFIELD	FBH 578	11.00	0.00	0.0000	0		
	3	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	720	60.73	$177.33
						TOTAL		720	60.73	$177.33

[BOILERS.WK3]

APPENDIX D

ECO ANALYSIS

CENTRAL PLANT 730

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 730
ENERGY CONSERVATION OPPORTUNITY: ECO-1
SYSTEM MODIFICATION: ADD INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-1, install instrumentation to facilitate efficient operation of chiller plant.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	525	883,000	20,988	24,002
ECO	396	640,000	20,988	23,172
Savings (Baseline-ECO)	129	243,000	0	829

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 829 MMBtu/Yr X $4.0141 /MMBtu = $3,329 per year

Nat. Gas: 0 MMBtu/Yr X $2.92 /MMBtu = $0 per year

Total Energy Cost Savings: $3,329 + $0 = $3,329 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 129 kW/month X $1.787 /kW X 12 months/year

= (+) $2,766 per year

Maintenance: = (-) $320 per year

Total: $2,766 - $320 = $2,446 per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	20987.
PEAK DAY GAS CONSUMP., 1000 CU FT	287.
ELECTRICAL CONSUMPTION, KWH	883113.
PEAK KW DEMAND (15 MIN BASIS)	525.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	883113.
ON-PEAK KW DEMAND (15 MIN BASIS)	525.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
BOILER OPERATING HOURS	
BOILER 1	1507
BOILER 2	980
BOILER 3	570
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

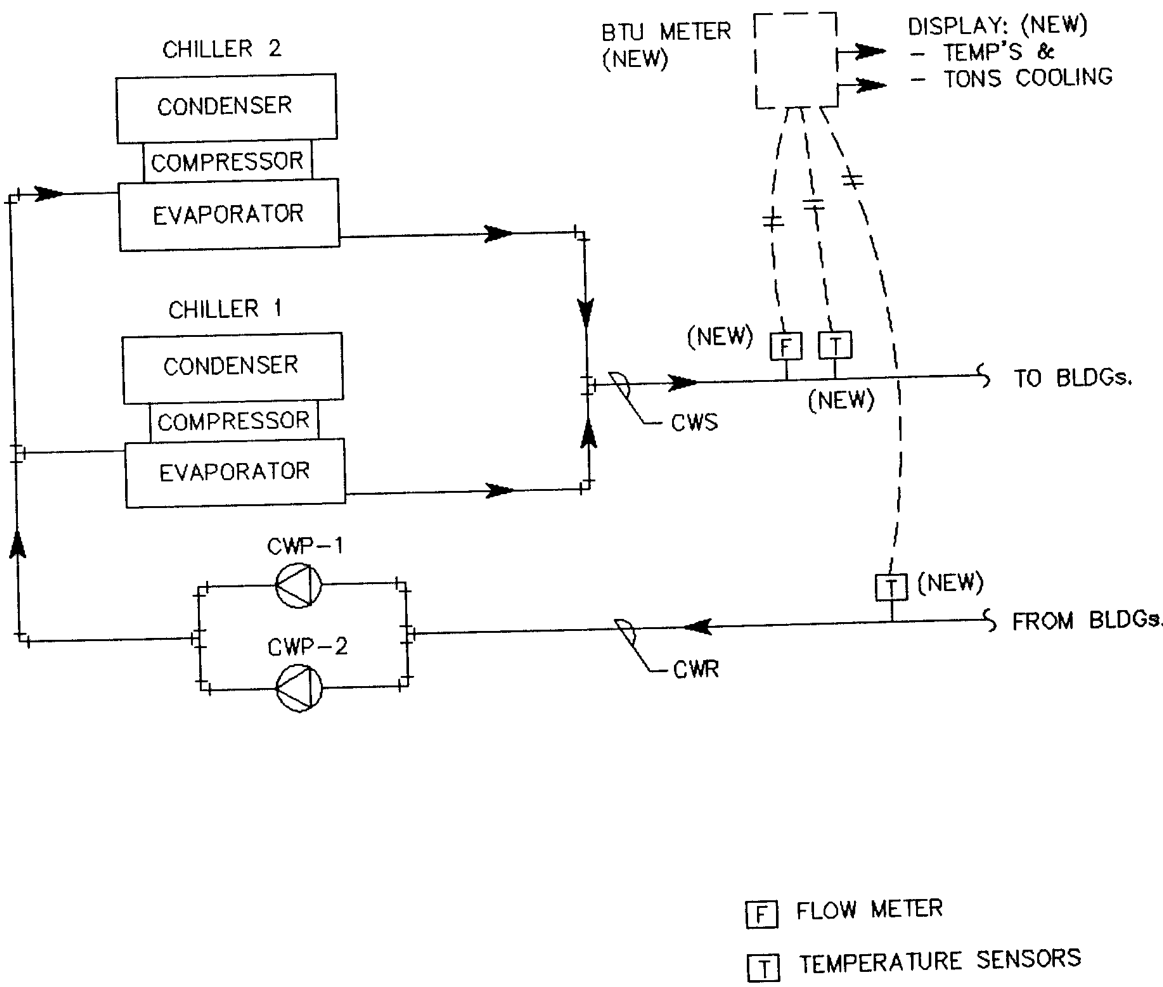
CENTRAL PLANT 730 CHILLER ECO-1

** TOTAL **

SYSTEM C1 NORMAL HTG & COOLING W/kW PUMP REDUCTION

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	20987.
PEAK DAY GAS CONSUMP., 1000 CU FT	287.
ELECTRICAL CONSUMPTION, KWH	641100.
PEAK KW DEMAND (15 MIN BASIS)	396.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	641100.
ON-PEAK KW DEMAND (15 MIN BASIS)	396.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
BOILER OPERATING HOURS	
BOILER 1	1507
BOILER 2	980
BOILER 3	570
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

ECO–1, INSTRUMENTATION FOR CHILLER PLANT
(TYPICAL)



[C-ECO-1.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.	DACA 59-90-C-0087
CODE A	X
CODE B	
CODE C	
OTHER	
EFFECTIVE PRICING DATE	APR. 91
DATE PREPARED	04-Apr-91
DRAWING NO.	
SHT	OF
ESTIMATOR	KC
CHECKED BY	CEL
PROJECT	ENERGY SURVEY OF ARMY BOILER AND CHILLER
LOCATION	FT. SILL, OKLAHOMA

CHILLER ECO-1 BLDG. 730	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
INSTRUMENTATION	No. Of	Unit	MH/	Total	Unit		Unit		Unit			Unit	Total
TASK DESCRIPTION	Units	Meas	Unit	Hrs	Price	Cost	Price	Cost	Price	Cost		Wt	Wt
INSTRUMENTATION FOR 2 CHILLERS													
CHWS TEMPERATURE SENSOR	1	EA			$176	$176			$328	$328	$504		
CHWR TEMPERATURE SENSOR	1	EA			$176	$176			$328	$328	$504		
INSERT. FLOW METER	1	EA			$197	$197			$764	$764	$961		
BTU METER	1	EA	6.0	6.0	$20	$118			$820	$820	$938		
LED DISPLAY	2	EA							$60	$120	$120		
LED INSTALLATION	2	EA	4.6	9.2	$20	$180			$158	$316	$496		
SUBTOTAL						$847				$2,676	$3,523		
OVERHEAD, BOND	16%					$136				$428	$564		
PROFIT	10%					$85				$268	$352		
COST SUB-TOTAL						$1,067				$3,372	$4,439		
CONTINGENCY	20%					$213				$674	$888		
SUBTOTAL						$1,281				$4,046	$5,327		
S&A	5.5%					$70				$223	$293		
TOTAL THIS SHEET						$1,351				$4,269	$5,620		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C730ECO
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER INSTRUMENTATION
ANALYSIS DATE: 04-08-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	5327.
B. SIOH	$	293.
C. DESIGN COST	$	320.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	5346.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	5346.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	829.	$ 3328.	8.78	29216.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	0.	$ 0.	12.48	0.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		829.	$ 3328.		$ 29216.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 2446.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 22283.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 22283.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 9641.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= 7.27
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 5774.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 51499.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 9.63
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 .93

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 730
ENERGY CONSERVATION OPPORTUNITY: ECO-2
SYSTEM MODIFICATION: CHILLER OPTIMIZATION, ADD INSTRUMENTATION
SYSTEMS TO MODIFY: CHILLER 1 AND 3

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-2, install instrumentation connected to EMCS for chiller optimization.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	525	883,000	20,988	24,002
ECO	362	545,000	20,988	22,848
Savings (Baseline-ECO)	163	338,000	0	1,154

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	1154 MMBtu/Yr	X	$4.0141 /MMBtu	=	$4,631 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$4,631**	+	**$0**	=	**$4,631 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 163 kW/month X $1.787 /kW X 12 months/year

= (+) $3,495 per year

Maintenance: = (-) $1,077 per year

Total: $3,495 - $1,077 = $2,418 per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	20987.
PEAK DAY GAS CONSUMP., 1000 CU FT	287.
ELECTRICAL CONSUMPTION, KWH	883113.
PEAK KW DEMAND (15 MIN BASIS)	525.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	883113.
ON-PEAK KW DEMAND (15 MIN BASIS)	525.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
BOILER OPERATING HOURS	
BOILER 1	1507
BOILER 2	980
BOILER 3	570
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

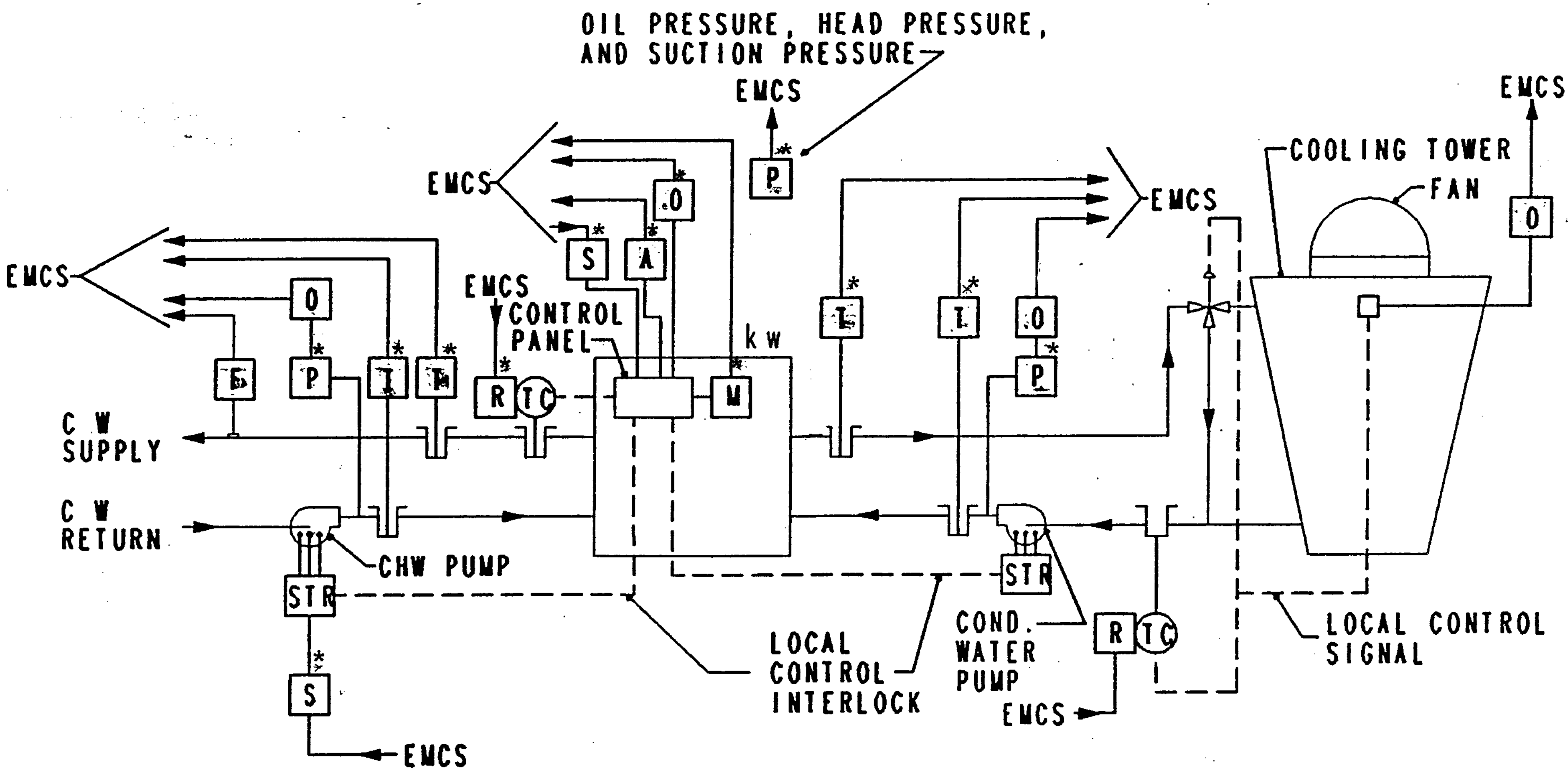
PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 CHILLER ECO-2

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

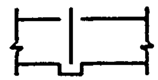
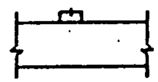
FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	20987.
PEAK DAY GAS CONSUMP., 1000 CU FT	287.
ELECTRICAL CONSUMPTION, KWH	545601.
PEAK KW DEMAND (15 MIN BASIS)	362.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	545601.
ON-PEAK KW DEMAND (15 MIN BASIS)	362.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
CHILLER 2	0
BOILER OPERATING HOURS	
BOILER 1	1507
BOILER 2	980
BOILER 3	570
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.



Water cooled chiller

* – Points included on proposed EMCS design, existing.
All other points are new.

→ EMCS	SIGNAL TRANSMITTED TO EMCS
← EMCS	SIGNAL TRANSMITTED FROM EMCS
$\boxed{A}$	ALARM CONTACT SIGNAL
$\boxed{E}$	ECONOMIZER CONTROL INTERFACE
$\boxed{F}$	FLOW INDICATION
$\boxed{FL}$	FLAME INDICATION
$\boxed{H}$	HUMIDITY INDICATION
$\boxed{P}$	PRESSURE INDICATION
$\boxed{LV}$	LEVEL INDICATION
$\boxed{M}$	METER
$\boxed{O}$	ON-OFF STATUS SIGNAL
$\boxed{DP}$	DIFFERENTIAL PRESSURE SWITCH
$\boxed{R}$	CONTROLLER RESET INTERFACE
$\boxed{S}$	START-STOP INTERFACE
$\boxed{T}$	TEMPERATURE INDICATION
$\boxed{V}$	VENTILATION/RECIRCULATION CONTROL
$\boxed{PS}$	POSITION
$\boxed{O_2}$	FLUE GAS ANALYSIS, OXYGEN
$\boxed{C_O}$	FLUE GAS ANALYSIS, CARBON MONOXIDE

$\boxed{FD}$	FURNACE DRAFT DIFFERENTIAL PRESSURE
$\boxed{DS}$	HIGH-LOW DEMAND SIGNAL SELECTOR
TC	TEMPERATURE CONTROLLER
PC	PRESSURE CONTROLLER
$\boxed{STR}$	MOTOR STARTER
	SENSOR INSTALLED IN THERMOMETER WELL
	SENSOR INSTALLED IN DUCT OR PLENUM
CHW	CHILLED WATER
EA	EXHAUST AIR
SA	SUPPLY AIR
RA	RETURN AIR
OA	OUTSIDE AIR
MA	MIXED AIR
WB	WET BULB
DB	DRY BULB
OAD	OUTSIDE AIR DAMPER
RAD	RETURN AIR DAMPER
EAD	EXHAUST AIR DAMPER
MZD	MULTIZONE DAMPER
RH	RELATIVE HUMIDITY

Symbols and Abbreviations

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ____

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO-2 BLDG. 730 / OPTIMIZE CHILLER SEQUENCE / TASK DESCRIPTION		Quantity: No. Of Units	Quantity: Unit Meas	LABOR: MH/ Unit	LABOR: Total Hrs	LABOR: Unit Price	LABOR: Cost	EQUIPMENT: Unit Price	EQUIPMENT: Cost	MATERIAL: Unit Price	MATERIAL: Cost	TOTAL	SHIPPING: Unit Wt	SHIPPING: Total Wt
INSTRUMENTATION FOR 2 CHILLERS														
CHWS/R TEMPERATURE SENSOR	*	2	LS			176	352			328.00	656.00	$1,664		
CHWS/R TEMPERATURE SENSOR		4	LS			176	704			328.00	1312.00	$2,016		
CNWS/R TEMPERATURE SENSOR	*	2	LS			176	352			328.00	656.00	$1,664		
CNWS/R TEMPERATURE SENSOR		4	LS			176	704			328.00	1312.00	$2,016		
INSERT. FLOW METER		3	LS			197	591			764.00	2292.00	$2,883		
CHWP ST/SP	*	1	LS			39.2	39.2			226	226	491.2		
CHWP ST/SP		1	LS			39	39			226.00	226.00	$265		
CNWP ST/SP	*	1	LS			39	39			226.00	226.00	$491		
CNWP ST/SP		1	LS			39	39			226.00	226.00	$265		
DP (LIQUID) PUMP STATUS	*	2	LS			155	310			205.00	410.00	$1,130		
DP (LIQUID) PUMP STATUS		2	LS			155	310			205.00	410.00	$720		
COOLING TOWER ST/SP		2	LS			39	78			226.00	452.00	$530		
COOLING TOWER ST/SP STATUS		2	LS			104	208			53.00	106.00	$314		
CHW TEMP CONTROL	*	1	EA	5.5	5.5	20	108			558.00	558.00	$1,224		
CHILLER ST/SP	*	1	EA	2.0	2.0	20	39			226.00	226.00	$491		
CHW TEMP CONTROL		1	EA	5.5	5.5	20	108			558.00	558.00	$666		
CHILLER ST/SP		1	EA	2.0	2.0	20	39			226.00	226.00	$265		
kW TRANSDUCER	*	1	LS			226	226			374.00	374.00	$974		
kW TRANSDUCER		1	LS			226	226			374.00	374.00	$600		
CURRENT TRANSDUCER		2	LS			126	252			270.00	540.00	$792		
FID PANEL & ACCESSORIES	*	1	LS			208	208			3681.00	3681.00	$7,570		
FID SOFTWARE COMMISSIONING		1	EA	6.0	6.0	45	270					$270		
FID TESTING		1	EA	6.0	6.0	45	270					$270		
CREDIT FROM EMCS PROJECT	*						-1673				-7013.00	($8,686)		
SUBTOTAL							$3,839				$8,034	$11,873		
OVERHEAD, BOND		16%					$614				$1,285	$1,900		
PROFIT		10%					$384				$803	$1,187		
COST SUB-TOTAL							$4,837				$10,123	$14,960		
CONTINGENCY		20%					$967				$2,025	$2,992		
SUBTOTAL							$5,804				$12,147	$17,952		
S&A		5.5%					$319				$668	$987		
TOTAL [illegible] SHEET							$6,124				$12,816	$18,939		

DA FORM 54[illegible]-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C730ECO
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER OPTIMIZATION
ANALYSIS DATE: 04-08-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	17952.
B. SIOH	$	988.
C. DESIGN COST	$	1078.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	18016.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	18016.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	1154.	$ 4632.	8.78	40670.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	0.	$ 0.	12.48	0.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		1154.	$ 4632.		$ 40670.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 2418.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 22028.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 22028.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 13421.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= 3.00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 7050.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 62698.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 3.48
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 2.56

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 730
ENERGY CONSERVATION OPPORTUNITY: ECO-3
SYSTEM MODIFICATION: MINOR RENOVATION, CHILLER 1&3
SYSTEMS TO MODIFY: CHILLER 1, 3

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-3, renovate or replace existing chillers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	525	883,000	20,988	24,002
ECO	503	881,000	20,988	23,995
Savings (Baseline-ECO)	22	2,000	0	7

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	7 MMBtu/Yr	X	$4.0141 /MMBtu	=	$27 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$27**	+	**$0**	=	**$27 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 22 kW/month X $1.787 /kW X 12 months/year

= (+) $472 per year

Maintenance: = (-) $3,000 per year

Total: $472 - $3,000 = ($2,528) per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	20987.
PEAK DAY GAS CONSUMP., 1000 CU FT	287.
ELECTRICAL CONSUMPTION, KWH	883113.
PEAK KW DEMAND (15 MIN BASIS)	525.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	883113.
ON-PEAK KW DEMAND (15 MIN BASIS)	525.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
BOILER OPERATING HOURS	
BOILER 1	1507
BOILER 2	980
BOILER 3	570
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 CHILLER ECO-3

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	20987.
PEAK DAY GAS CONSUMP., 1000 CU FT	287.
ELECTRICAL CONSUMPTION, KWH	880838.
PEAK KW DEMAND (15 MIN BASIS)	503.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	880838.
ON-PEAK KW DEMAND (15 MIN BASIS)	503.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
BOILER OPERATING HOURS	
BOILER 1	1507
BOILER 2	980
BOILER 3	570
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

☐ CODE A ☒ CODE B ☐ CODE C
☐ OTHER ____________

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 29-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO-3 BLDG. 730	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
HIGH EFFICIENCY CHILLERS / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CHILLER RENOVATION													
800 TON CHILLER MINOR MAINTENANCE	1	LS			1984	1984					$1,984		
300 TON CHILLER MINOR MAINTENANCE	1	LS			1984	1984					$1,984		
SUBTOTAL						$3,968					$3,968		
OVERHEAD, BOND	16%					$635					$635		
PROFIT	10%					$397					$397		
COST SUB-TOTAL						$5,000					$5,000		
CONTINGENCY	20%					$1,000					$1,000		
SUBTOTAL						$6,000					$6,000		
S&A	5.5%					$330					$330		
TOTAL [illegible] SHEET						$6,330					$6,330		

DA FORM 5[illegible], APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C730EC3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER MAINTENANCE
ANALYSIS DATE: 04-29-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	6000.
B. SIOH	$	330.
C. DESIGN COST	$	360.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	6021.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	6021.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	7.	$ 27.	8.78	241.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	0.	$ 0.	12.48	0.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		7.	$ 27.		$ 241.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -2528.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -23030.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -23030.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 79.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -2501.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -22789.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -3.78
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -2.41

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 730
ENERGY CONSERVATION OPPORTUNITY: ECO-4
SYSTEM MODIFICATION: INSTALL ICE STORAGE COOLING SYSTEM
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Hand calculation sheet was prepared to determine the energy savings for ECO-4, install ice storage system for HVAC cooling.
It was estimated that the peak electrical demand can be saved by installing ice storage cooling system.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	712	0	0	0

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 0 MMBtu/Yr X $4.0141 /MMBtu = $0 per year

Nat. Gas: 0 MMBtu/Yr X $2.92 /MMBtu = $0 per year

Total Energy Cost Savings: $0 + $0 = $0 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 712 kW/month X $1.787 /kW X 12 months/year

= (+) $15,268 per year

Maintenance: = (-) $0 per year

Total: $15,268 - $0 = $15,268 per year

[ECO-SHT.WK3]

A new application of an old idea that can cut air conditioning energy costs in half.

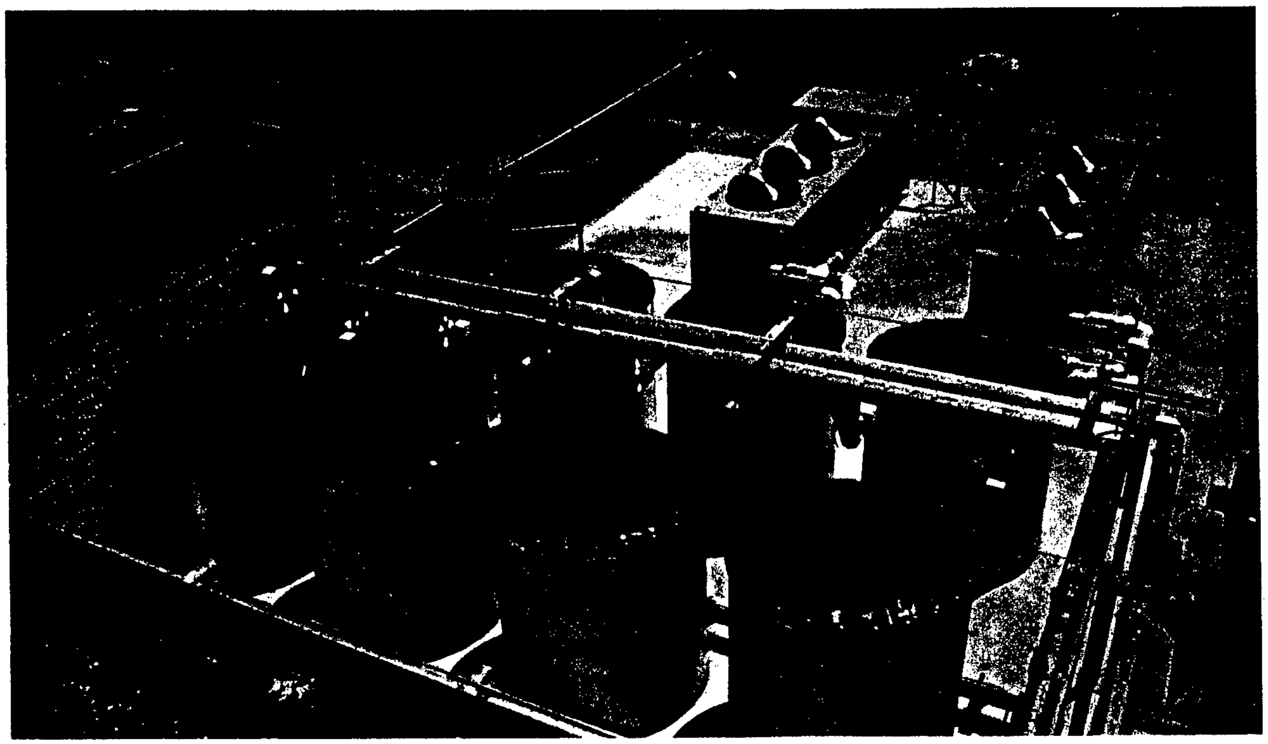
Air conditioning during summer daytime hours is the largest single contributor to utility "peak demand" charges. After noon, as more air conditioners are needed to maintain comfortable temperatures, the increased demand for electricity adds to that already created by lighting, operating equipment, computers and thousands of other uses. This requires the utility to bring additional, more costly generating sources on line to handle its increased demand. Commercial users whose large air conditioning loads contribute to these added generating requirements are assessed an additional charge based on their highest on-peak demand for electricity.

An Ice Bank Stored Cooling System is either a load-shifting or load-leveling method which will significantly lower demand charges during the air conditioning season and, consequently, energy costs. It uses a standard packaged chiller to produce solid ice at night during off-peak periods when the building's electrical needs are at a minimum. The ice is built and stored in modular ice tanks to provide cooling to help meet the building's air conditioning load requirement the following day.

Making ice at night and using its stored energy during the day is not a new or experimental idea. This concept had been employed for years in cooling short-peak applications such as churches and theatres. However, longer peak uses were served by air-source rooftop and chiller-type air conditioners which were less costly to install. Now there is renewed interest in a broad use of ice-making systems by both users and utilities as the best way to offset rising operating costs. In fact, Stored Cooling Systems are what summer-peaking utilities *must have* to avoid the unbearable costs of new generating plants.

Ice Banks not only can cut operating costs in half but they can also substantially reduce capital outlays when systems are suitably designed for new commercial and industrial buildings. Engineers can specify half-size chillers operating 24 hours a day rather than full-size chillers operating only 10 or 12 hours per day. In retrofit applications, an Ice Bank Stored Cooling System can often provide cooling for an addition to a building without adding chiller capacity.

Atlantic Southern Properties Mays Landing NJ



How the LEVLOAD System Works

The LEVLOAD Ice Bank is a modular, insulated polyethylene tank containing a spiral-wound plastic tube heat exchanger surrounded with water. They are available in four sizes – 90, 100, 190 and 570 ton-hours. At night, a 75 percent water-25 percent glycol solution from a standard packaged air conditioning chiller circulates through the heat exchanger and extracts heat until eventually all the water in the tank is frozen solid. The ice is built uniformly throughout the tank by the patented temperature-averaging effect of closely spaced counterflow heat exchanger tubes, Figure 5. Water does not become surrounded by ice during the freezing process and can move freely as ice forms, preventing stress or damage to the tank.

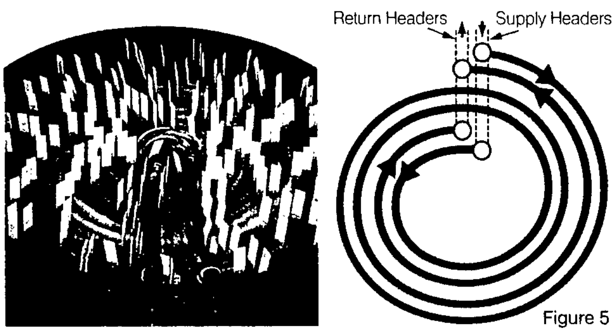


Figure 5

Typical flow diagrams for a Partial Storage System are shown in Figures 6 and 7.

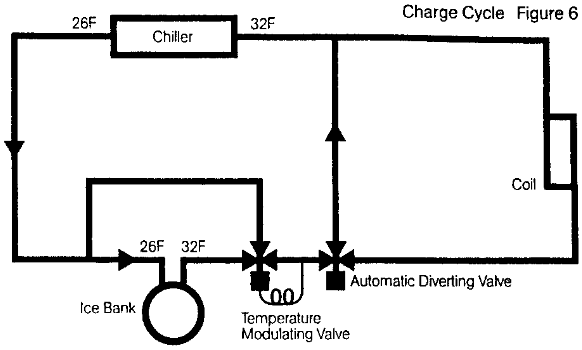
At night, the water-glycol solution circulates through the chiller and the Ice Bank heat exchanger, bypassing the air handler coil. The fluid is at 26F and freezes the water surrounding the heat exchanger.

During the day, the solution is cooled by the Ice Bank from 52F to 34F. A temperature modulating valve set at 44F in a bypass loop around the Ice Bank permits a sufficient quantity of 52F fluid to bypass the Ice Bank, mix with the 34F fluid, and achieve the desired 44F temperature. The 44F fluid enters the coil, where it cools air from 75F to 55F. The fluid leaves the coil at 60F, enters the chiller and is cooled to 52F.

It should be noted that, while making ice at night, the chiller must cool the water-glycol solution to 26F, rather than produce 44 or 45F water temperatures required for conventional air conditioning systems. This has the effect of "derating" the nominal chiller capacity by approximately 30 percent. Compressor efficiency, however, is only slightly reduced because lower nighttime temperatures result in cooler condenser water from the cooling tower and help keep the unit operating efficiently. Similarly, air cooled chillers benefit from cooler condenser entering air temperatures at night.

The temperature modulating valve in the bypass loop has the added advantage of providing unlimited capacity control. During many mild temperature days in the spring and fall, the chiller will be capable of providing all the necessary cooling for the building without assistance from stored cooling. When the building's actual cooling load is equal to or lower than the chiller capacity, all of the system coolant flows through the bypass loop, as in Figure 8.

Charge Cycle Figure 6



Discharge Cycle Figure 7

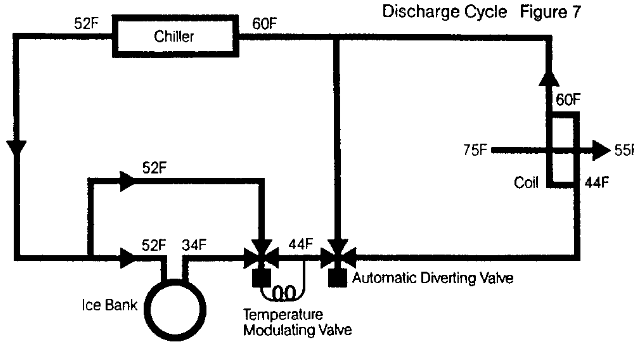
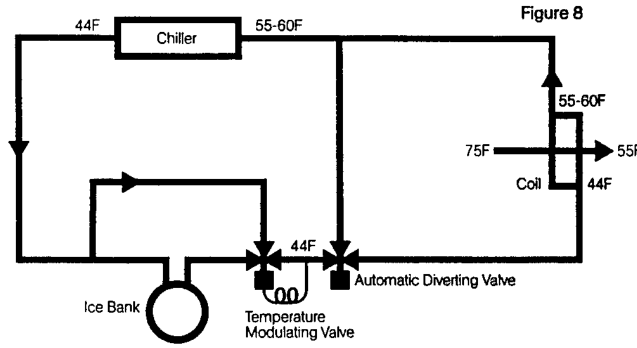


Figure 8



The glycol recommended for the solution is an ethylene glycol-based industrial coolant, such as Dow Chemical Company's Dowtherm® SR-1 or Union Carbide Corporation's UCARTHERM,® which are specially formulated for low viscosity and superior heat transfer properties. These contain a multi-component corrosion inhibitor system which is effective with most materials of construction, including aluminum, copper, solder and plastics. Unlike automotive-type anti-freeze, they produce no films and contain no anti-leak agents to interfere with heat transfer efficiency and permit use of standard system pumps, seals and air handler coils. However, because of the slight difference in heat transfer coefficient between water-glycol and plain water, coil capacity should be increased by approximately 5 percent. It is also important that the water and glycol be thoroughly mixed before the solution enters the system.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 730EC4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ICE STORAGE COOLING SYSTEM
ANALYSIS DATE: 04-18-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	192000.
B. SIOH	$	10560.
C. DESIGN COST	$	11520.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	192672.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	192672.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 15268.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 177872.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 177872.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 0.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 15268.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 177872.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .92
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 12.62

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 730
ENERGY CONSERVATION OPPORTUNITY: ECO- 5(A)
SYSTEM MODIFICATION: TWO SPEED FANS FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER

CALCULATION DESCRIPTION:

Two spread sheets are compared to determine the energy savings for ECO-5, install two-speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	32,299	--	110
ECO	--	14,858	--	51
Savings (Baseline-ECO)	0	17,441	0	60

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	60 MMBtu/Yr	X	$4.0141 /MMBtu	=	$239 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$239**	**+**	**$0**	**=**	**$239 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $0 per year

Total: **$0** **-** **$0** **=** **$0 per year**

[ECO-SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input. The calculations take into account multi-cell towers (part 7). The control sequence is:

- 0-25% load, fan 1, half speed cycling.
- 25-50% load, fan 1 half speed running, fan 2 half speed cycling:
- 50-75% load, fan 1 full speed cycling, fan 2 half speed running.
- 75-100% load, fan 1 full speed running, fan 2 full speed cycling.

kWh per bin, for % design loads less than 25% load = (fan 1 power kW) * 14% * (%design load / 25) * 4 hours per bin * days per month.

kWh per bin, for % design loads 25% to 50% load = (fan 1 power kW * 14% * 4 hours per bin * days per month) * (fan 2 power kW * 14% * ((% design load - 25)/ 25)* 4 hours per bin * days per month)

kWh per bin, for % design loads 50% to 75% load = (fan 2 power kW * 14% * 4 hours per bin * days per month) * (fan 1 power kW * ((% design load - 50)/ 25) * 4 hours per bin * days per month)

kWh per bin, for % design loads 75% to 100% load = (fan 1 power kW * 4 hours per bin * days per month) + (fan 2 power kW * ((% design load - 75)/ 25) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 730	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	77
– WATER FLOW (gpm)	2600
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	10790
HEAT REJECTION CAPACITY (Btu/min)	215800
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	40.57
TOTAL ENTHALPY	60.57
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	162929
MOTOR DATA	
– FAN 1 POWER (kW)	23
– FAN 2 POWER (kW)	23

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET-BULB AVERAGES (4 hour bins)						DESIGN WB
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	77
MAY	57.1	56.6	61.2	63.9	63	59.4	77
JUNE	66.8	66.6	69.9	71	70.5	68.2	77
JULY	70.8	70.9	74.5	76	74.9	72.6	77
AUGUST	66.9	67	71	72	71	68.5	77
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	77
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	77

	ENTHALPY FOR AVERAGE WET-BULBS						DESIGN ENTHALPY
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	40.57
MAY	24.53	24.21	27.28	29.23	28.57	26.06	40.57
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	40.57
JULY	34.77	34.86	38.14	39.57	38.52	36.37	40.57
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	40.57
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	40.57
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	40.57

			COOLING PROFILE OF CENTRAL PLANTS				PEAK LOAD
	1–4	5–8	9–12	13–16	17–20	21–24	(Btuh)
APRIL	0	0.8	0.5	0.4	0	0	992000
MAY	0	0.9	0.6	0.8	0	0	4312000
JUNE	0	0.9	0.6	0.8	0	0	11526000
JULY	0	0.9	0.6	0.8	0	0	11526000
AUGUST	0	0.9	0.6	0.8	0	0	11526000
SEPTEMBER	0	0.9	0.6	0.8	0	0	11526000
OCTOBER	0	0.8	0.5	0.4	0	0	2244000

			RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY				DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	2.0	2.1	2.0	1.8	1.9	2.0	22
MAY	1.8	1.8	1.7	1.6	1.6	1.7	23
JUNE	1.5	1.5	1.3	1.3	1.3	,1.4	22
JULY	1.3	1.3	1.1	1.1	1.1	1.2	23
AUGUST	1.5	1.4	1.3	1.2	1.3	1.4	23
SEPTEMBER	1.5	1.5	1.4	1.4	1.4	1.5	22
OCTOBER	2.0	2.0	1.9	1.8	1.9	1.9	23

			% DESIGN LOAD				DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	0.0	3.3	2.2	1.9	0.0	0.0	22
MAY	0.0	18.5	13.5	19.1	0.0	0.0	23
JUNE	0.0	61.5	45.2	62.5	0.0	0.0	22
JULY	0.0	70.0	53.5	76.2	0.0	0.0	23
AUGUST	0.0	62.2	46.8	64.7	0.0	0.0	23
SEPTEMBER	0.0	58.8	42.4	58.2	0.0	0.0	22
OCTOBER	0.0	7.8	5.2	4.3	0.0	0.0	23

			SINGLE SPEED COOLING TOWER CYCLING (kWh)				TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	134	89	75	0	0	
MAY	0	784	571	808	0	0	
JUNE	0	2490	1829	2528	0	0	
JULY	0	2963	2264	3224	0	0	
AUGUST	0	2631	1982	2737	0	0	
SEPTEMBER	0	2382	1715	2357	0	0	
OCTOBER	0	329	221	184	0	0	
TOTAL	0	11714	8671	11914	0	0	32299

TWO SPEED COOLING TOWER CYCLING (kWh)							TOTAL (kWh)
	1-4	5-8	9-12	13-16	17-20	21-24	
APRIL	0	38	25	21	0	0	
MAY	0	219	160	226	0	0	
JUNE	0	1216	512	1291	0	0	
JULY	0	1990	592	2513	0	0	
AUGUST	0	1327	555	1538	0	0	
SEPTEMBER	0	999	480	949	0	0	
OCTOBER	0	92	62	51	0	0	
TOTAL	0	5881	2387	6591	0	0	14858

VARIABLE SPEED COOLING TOWER CYCLING (kWh)							TOTAL (kWh)
	1-4	5-8	9-12	13-16	17-20	21-24	
APRIL	0	0	0	0	0	0	
MAY	0	34	13	37	0	0	
JUNE	0	1178	467	1232	0	0	
JULY	0	1815	810	2340	0	0	
AUGUST	0	1272	544	1431	0	0	
SEPTEMBER	0	1031	385	999	0	0	
OCTOBER	0	2	1	0	0	0	
TOTAL	0	5332	2219	6039	0	0	13590

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

[ ] CODE A [X] CODE B [ ] CODE C

[ ] OTHER ______

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO BLDG. 730	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
2-SPEED COOLING TOWER TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
30 HP 2-SPD MOTOR	2	EA	3.3	6.7	20	131			3306.00	6612.00	$6,743		
2-SPD MOTOR STARTER	2	EA	4.2	8.4	20	165			859.00	1718.00	$1,883		
MOTOR FEEDER	2	LS	4.1	8.1	20	160			20.00	40.00	$200		
REMOVE OLD MOTOR	2	EA	3.3	6.7	20	131					$131		
REMOVE OLD STR	2	EA	4.2	8.4	20	165					$165		
PNEUMATIC THERMOSTAT	4	EA	1.0	4.0	20	78			34.12	136.48	$215		
SUBTOTAL						$828				$8,506	$9,335		
OVERHEAD, BOND	16%					$133				$1,361	$1,494		
PROFIT	10%					$83				$851	$933		
COST SUB-TOTAL						$1,044				$10,718	$11,762		
CONTINGENCY	20%					$209				$2,144	$2,352		
SUBTOTAL						$1,252				$12,862	$14,114		
S&A	5.5%					$69				$707	$776		
TOTAL THIS SHEET						$1,321				$13,569	$14,890		

DA FORM [illegible], APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 730EC5A
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	14114.
B. SIOH	$	777.
C. DESIGN COST	$	847.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	14164.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	14164.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	60.	$ 239.	11.37	2717.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		60.	$ 239.		$ 2717.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 897.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 239.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2717.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .19
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 59.27

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 730
ENERGY CONSERVATION OPPORTUNITY: ECO– 5(B)
SYSTEM MODIFICATION: VARIABLE SPEED DRIVE FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER

CALCULATION DESCRIPTION:
Two PC–CUBE program computer runs are compared to determine the energy savings for ECO–5, install two–speed (5A) or variable speed (5B) motors for cooling tower.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	––	32,299	––	110
ECO	––	13,590	––	46
Savings (Baseline–ECO)	0	18,709	0	64

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	64 MMBtu/Yr	X	$4.0141 /MMBtu	=	$256 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$256**	**+**	**$0**	**=**	**$256 per year**

NON–ENERGY SAVINGS (+), COST (–):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (–) $579 per year

Total: $0 – $579 = ($579)per year

[ECO–SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input. The calculations take into account multi-cell towers (part 7). The control sequence is:

- 0-25% load, fan 1, half speed cycling.
- 25-50% load, fan 1 half speed running, fan 2 half speed cycling:
- 50-75% load, fan 1 full speed cycling, fan 2 half speed running.
- 75-100% load, fan 1 full speed running, fan 2 full speed cycling.

kWh per bin, for % design loads less than 25% load = (fan 1 power kW) * 14% * (%design load / 25) * 4 hours per bin * days per month.

kWh per bin, for % design loads 25% to 50% load = (fan 1 power kW * 14% * 4 hours per bin * days per month) * (fan 2 power kW * 14% * ((% design load - 25)/ 25)* 4 hours per bin * days per month)

kWh per bin, for % design loads 50% to 75% load = (fan 2 power kW * 14% * 4 hours per bin * days per month) * (fan 1 power kW * ((% design load - 50)/ 25) * 4 hours per bin * days per month)

kWh per bin, for % design loads 75% to 100% load = (fan 1 power kW * 4 hours per bin * days per month) + (fan 2 power kW * ((% design load - 75)/ 25) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 730	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	77
– WATER FLOW (gpm)	2600
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	10790
HEAT REJECTION CAPACITY (Btu/min)	215800
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	40.57
TOTAL ENTHALPY	60.57
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	162929
MOTOR DATA	
– FAN 1 POWER (kW)	23
– FAN 2 POWER (kW)	23

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET–BULB AVERAGES (4 hour bins)						DESIGN WB
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	77
MAY	57.1	56.6	61.2	63.9	63	59.4	77
JUNE	66.8	66.6	69.9	71	70.5	68.2	77
JULY	70.8	70.9	74.5	76	74.9	72.6	77
AUGUST	66.9	67	71	72	71	68.5	77
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	77
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	77

	ENTHALPY FOR AVERAGE WET–BULBS						DESIGN ENTHALPY
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	40.57
MAY	24.53	24.21	27.28	29.23	28.57	26.06	40.57
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	40.57
JULY	34.77	34.86	38.14	39.57	38.52	36.37	40.57
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	40.57
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	40.57
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	40.57

COOLING PROFILE OF CENTRAL PLANTS	1-4	5-8	9-12	13-16	17-20	21-24	PEAK LOAD (Btuh)
APRIL	0	0.8	0.5	0.4	0	0	992000
MAY	0	0.9	0.6	0.8	0	0	4312000
JUNE	0	0.9	0.6	0.8	0	0	11526000
JULY	0	0.9	0.6	0.8	0	0	11526000
AUGUST	0	0.9	0.6	0.8	0	0	11526000
SEPTEMBER	0	0.9	0.6	0.8	0	0	11526000
OCTOBER	0	0.8	0.5	0.4	0	0	2244000

RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY	1-4	5-8	9-12	13-16	17-20	21-24	DAYS PER MONTH OPER.
APRIL	2.0	2.1	2.0	1.8	1.9	2.0	22
MAY	1.8	1.8	1.7	1.6	1.6	1.7	23
JUNE	1.5	1.5	1.3	1.3	1.3	1.4	22
JULY	1.3	1.3	1.1	1.1	1.1	1.2	23
AUGUST	1.5	1.4	1.3	1.2	1.3	1.4	23
SEPTEMBER	1.5	1.5	1.4	1.4	1.4	1.5	22
OCTOBER	2.0	2.0	1.9	1.8	1.9	1.9	23

% DESIGN LOAD	1-4	5-8	9-12	13-16	17-20	21-24	DAYS PER MONTH OPER.
APRIL	0.0	3.3	2.2	1.9	0.0	0.0	22
MAY	0.0	18.5	13.5	19.1	0.0	0.0	23
JUNE	0.0	61.5	45.2	62.5	0.0	0.0	22
JULY	0.0	70.0	53.5	76.2	0.0	0.0	23
AUGUST	0.0	62.2	46.8	64.7	0.0	0.0	23
SEPTEMBER	0.0	58.8	42.4	58.2	0.0	0.0	22
OCTOBER	0.0	7.8	5.2	4.3	0.0	0.0	23

SINGLE SPEED COOLING TOWER CYCLING (kWh)	1-4	5-8	9-12	13-16	17-20	21-24	TOTAL (kWh)
APRIL	0	134	89	75	0	0	
MAY	0	784	571	808	0	0	
JUNE	0	2490	1829	2528	0	0	
JULY	0	2963	2264	3224	0	0	
AUGUST	0	2631	1982	2737	0	0	
SEPTEMBER	0	2382	1715	2357	0	0	
OCTOBER	0	329	221	184	0	0	
TOTAL	0	11714	8671	11914	0	0	32299

	TWO SPEED COOLING TOWER CYCLING (kWh)						TOTAL
	1-4	5-8	9-12	13-16	17-20	21-24	(kWh)
APRIL	0	38	25	21	0	0	
MAY	0	219	160	226	0	0	
JUNE	0	1216	512	1291	0	0	
JULY	0	1990	592	2513	0	0	
AUGUST	0	1327	555	1538	0	0	
SEPTEMBER	0	999	480	949	0	0	
OCTOBER	0	92	62	51	0	0	
TOTAL	0	5881	2387	6591	0	0	14858

	VARIABLE SPEED COOLING TOWER CYCLING (kWh)						TOTAL
	1-4	5-8	9-12	13-16	17-20	21-24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	0	34	13	37	0	0	
JUNE	0	1178	467	1232	0	0	
JULY	0	1815	810	2340	0	0	
AUGUST	0	1272	544	1431	0	0	
SEPTEMBER	0	1031	385	999	0	0	
OCTOBER	0	2	1	0	0	0	
TOTAL	0	5332	2219	6039	0	0	13590

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO BLDG. 730	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
VARIABLE SPEED COOLING TOWER TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
VFD FOR TWO 30 HP MOTOR	1	EA	4.0	4.0	20	78			5600.00	5600.00	$5,678		
VFD WIRING & CONNECTION	2	LS	4.1	8.1	20	160			20.00	40.00	$200		
WATER TEMPERATURE SENSOR	1	EA	9.0	9.0	20	176			328.00	328.00	$504		
SUBTOTAL						$414				$5,968	$6,382		
OVERHEAD, BOND	16%					$66				$955	$1,021		
PROFIT	10%					$41				$597	$638		
COST SUB-TOTAL						$522				$7,520	$8,041		
CONTINGENCY	20%					$104				$1,504	$1,608		
SUBTOTAL						$626				$9,024	$9,649		
S&A	5.5%					$34				$496	$531		
TOTA[illegible]IS SHEET						$660				$9,520	$10,180		

DA FORM[illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 730EC5B
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: VARIABLE SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	9649.
B. SIOH	$	531.
C. DESIGN COST	$	579.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	9683.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	9683.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	64.	$ 256.	11.37	2914.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		64.	$ 256.		$ 2914.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -579.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -6745.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -6745.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 962.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -323.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -3831.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.40
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -30.01

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 730
ENERGY CONSERVATION OPPORTUNITY: ECO-6
SYSTEM MODIFICATION: HIGH EFFICIENCY MOTOR REPLACEMENT
SYSTEMS TO MODIFY: PUMP & COOLING TOWER MOTORS

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-6, install high efficiency motors.
It was estimated that the electrical energy can be saved by installing high efficiency motors based on the motor operating hours per year.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	41	85,430	0	292

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	292 MMBtu/Yr	X	$4.0141 /MMBtu	=	$1,170 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$1,170**	**+**	**$0**	**=**	**$1,170 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 41 kW/month X $1.787 /kW X 12 months/year

= (+) $879 per year

Maintenance: = (-) $0 per year

Total: $879 - $0 = $879 per year

[ECO-SHT.WK3]

HIGH EFFICIENCY MOTOR REPLACEMENT

LABOR RATE:	19.6	$/hr
ELECTRIC CONS.	0.0137	$/kWH
ELECTRIC DEMAND	1.787	$/kW

BLDG. NO.	EQUIPMENT SERVE	MOTOR HP	MOTOR FLA	MEAS AMPS	MEAS PF	MEAS VOLT	EXST EFF	NEW EFF	KW SVGS	HRS/ YEAR	KWH/YR SVGS	SVGS/ YEAR
730	CWP-1	150.0	179.0	147.0	0.87	460	90.19%	95.00%	5.73	2641	15120	$330
	CWP-2	150.0	179.0	148.0	0.91	460	86.22%	95.00%	11.50	1873	21539	$542
	CNWP-1	50.0	118.0	107.0	0.98	230	80.97%	93.00%	6.67	2641	17629	$385
	CNWP-2	50.0	118.0	107.0	0.99	230	80.15%	93.00%	7.27	468	3405	$203
	CNWP-3	NI	NI	NI								
	CTM-1	30.0	71.4	70.7	0.93	230	84.60%	92.40%	2.61	702	1834	$81
	CTM-2	30.0	71.4	71.0	0.87	230	90.44%	92.40%	0.58	702	405	$18
	HWP-1	50.0	125.0	117.5	0.87	230	86.10%	93.00%	3.51	3624	12722	$250
	HWP-2	50.0	125.0	118.0	0.87	230	86.10%	93.00%	3.53	3624	12776	$251
		DEMAND CREDIT		$888	MMBtu	292		TOTAL	41		85430	$2,058
914	CWP-1	40.0	48.0	41.3	0.87	460	89.69%	93.00%	1.14	3672	4178	$82
	CNWP-1	15.0	19.0	14.4	0.82	460	90.15%	90.20%	0.01	3672	23	$0
	CTM-1	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	CTM-2	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	HWP-1	2.0	6.2	5.4	0.87	230	69.43%	84.00%	0.47	3624	1694	$33
	HWP-2	2.0	6.2	5.6	0.87	230	69.43%	84.00%	0.48	3624	1757	$34
		DEMAND CREDIT		$111	MMBtu	30		TOTAL	5		8932	$233
2812	CWP-1	20.0	27.0	23.0	0.77	460	90.07%	91.00%	0.16	3672	586	$11
	CNWP-1	25.0	31.5	26.5	0.82	460	91.18%	91.70%	0.11	3672	394	$8
	CTM-1	15.0	18.6	18.6	0.87	460	86.79%	90.20%	0.56	1167	655	$21
	HWP-1	7.5	21.6	18.5	0.87	230	74.74%	88.50%	1.33	5163	6888	$123
	HWP-2	7.5	21.6	19.0	0.87	230	74.74%	88.50%	1.37	3672	5031	$98
		DEMAND CREDIT		$76	MMBtu	46		TOTAL	4		13554	$261
3442	CWP-1	60.0	73.0	63.0	0.84	460	91.62%	94.50%	1.40	3672	5158	$101
	CWP-2	60.0	73.0	63.4	0.84	460	91.62%	94.50%	1.41	3672	5191	$101
	CNWP-1	40.0	52.0	41.0	0.78	460	92.34%	93.00%	0.20	3672	721	$14
	CNWP-2	40.0	52.0	35.8	0.78	460	92.34%	93.00%	0.17	3672	629	$12
	CTM-1	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-2	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-3	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-4	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
		DEMAND CREDIT		$90	MMBtu	44		TOTAL	4		12880	$266
4701	CWP-1	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CWP-2	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CNWP-1	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CNWP-2	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CTM-1	20.0	24.6	18.2	0.87	460	87.50%	91.00%	0.55	650	361	$17
	CTM-2	15.0	19.2	16.5	0.87	440	87.90%	90.20%	0.32	650	206	$10
		DEMAND CREDIT		$65	MMBtu	16		TOTAL	3		4605	$128
5676	HCP-1	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	HCP-2	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	10.5	9	0.79	460	84.66%	88.50%	0.29	1160	337	$11
		DEMAND CREDIT		$94	MMBtu	83		TOTAL	4		24287	$427
5678	HCP-1	2.0	6.5	5.9	0.83	208	76.76%	84.00%	0.20	7296	1445	$24
	HCP-2	2.0	6.5	5.7	0.83	208	76.76%	84.00%	0.19	7296	1396	$23
	HCP-3	1.5	4.8	4.5	0.83	230	70.51%	84.00%	0.34	7296	2474	$41
	HCP-4	2.0	6.3	5.8	0.83	230	71.62%	84.00%	0.39	7296	2878	$48
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	11	9.6	0.75	460	85.12%	88.50%	0.26	1139	293	$10
		DEMAND CREDIT		$64	MMBtu	49		TOTAL	3		14412	$262

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C

[ ] OTHER

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 10-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

MOTOR REP. ECO BLDG. 730

HIGH EFF. MOTOR REP.LACEMENT

	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CWP-1 150.0 HP MOTOR	1	EA	24.0	24.0	20	470			8028.0	8028.00	$8,498		
CWP-2 150.0 HP MOTOR	1	EA	24.0	24.0	20	470			8028.0	8028.00	$8,498		
CNWP-1 50.0 HP MOTOR	1	EA	9.0	9.0	20	176			2579.0	2579.00	$2,755		
CNWP-2 50.0 HP MOTOR	1	EA	9.0	9.0	20	176			2579.0	2579.00	$2,755		
CTM-1 30.0 HP MOTOR	1	EA	6.0	6.0	20	117			1639.0	1639.00	$1,756		
CTM-2 30.0 HP MOTOR	1	EA	6.0	6.0	20	117			1639.0	1639.00	$1,756		
HWP-1 50.0 HP MOTOR	1	EA	9.0	9.0	20	176			2579.0	2579.00	$2,755		
HWP-2 50.0 HP MOTOR	1	EA	9.0	9.0	20	176			2579.0	2579.00	$2,755		
SUBTOTAL						$1,881				$29,650	$31,531		
OVERHEAD, BOND	16%					$301				$4,744	$5,045		
PROFIT	10%					$188				$2,965	$3,153		
COST SUB-TOTAL						$2,370				$37,359	$39,729		
CONTINGENCY	20%					$474				$7,472	$7,946		
SUBTOTAL						$2,844				$44,831	$47,675		
S&A	5.5%					$156				$2,466	$2,622		
TOTA[illegible]IS SHEET						$3,001				$47,296	$50,297		

DA FORM [illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: 730EC6
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA — REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: HIGH EFF. MOTOR
ANALYSIS DATE: 04-10-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	47675.
B. SIOH	$	2623.
C. DESIGN COST	$	2861.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	47843.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	47843.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	292.	$ 1171.	11.37	13309.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		292.	$ 1171.		$ 13309.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 879.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 10240.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 10240.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 4392.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .37
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 2050.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 23549.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .49
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 23.34

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 730
ENERGY CONSERVATION OPPORTUNITY: ECO-7
SYSTEM MODIFICATION: INSTALL INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-7, install instrumentation to facilitate efficient operation of boiler plant. It was estimated that the energy wasted from boiler in standby is 1% of the rated output capacity. The hours when boilers are running unnecessary were estimated for each boiler.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	0	0	89	89

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	89 MMBtu/Yr	X	$2.92 /MMBtu	=	$260 per year
Total Energy Cost Savings:	**$0**	**+**	**$260**	**=**	**$260 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $255 per year

Total: $0 - $255 = ($255) per year

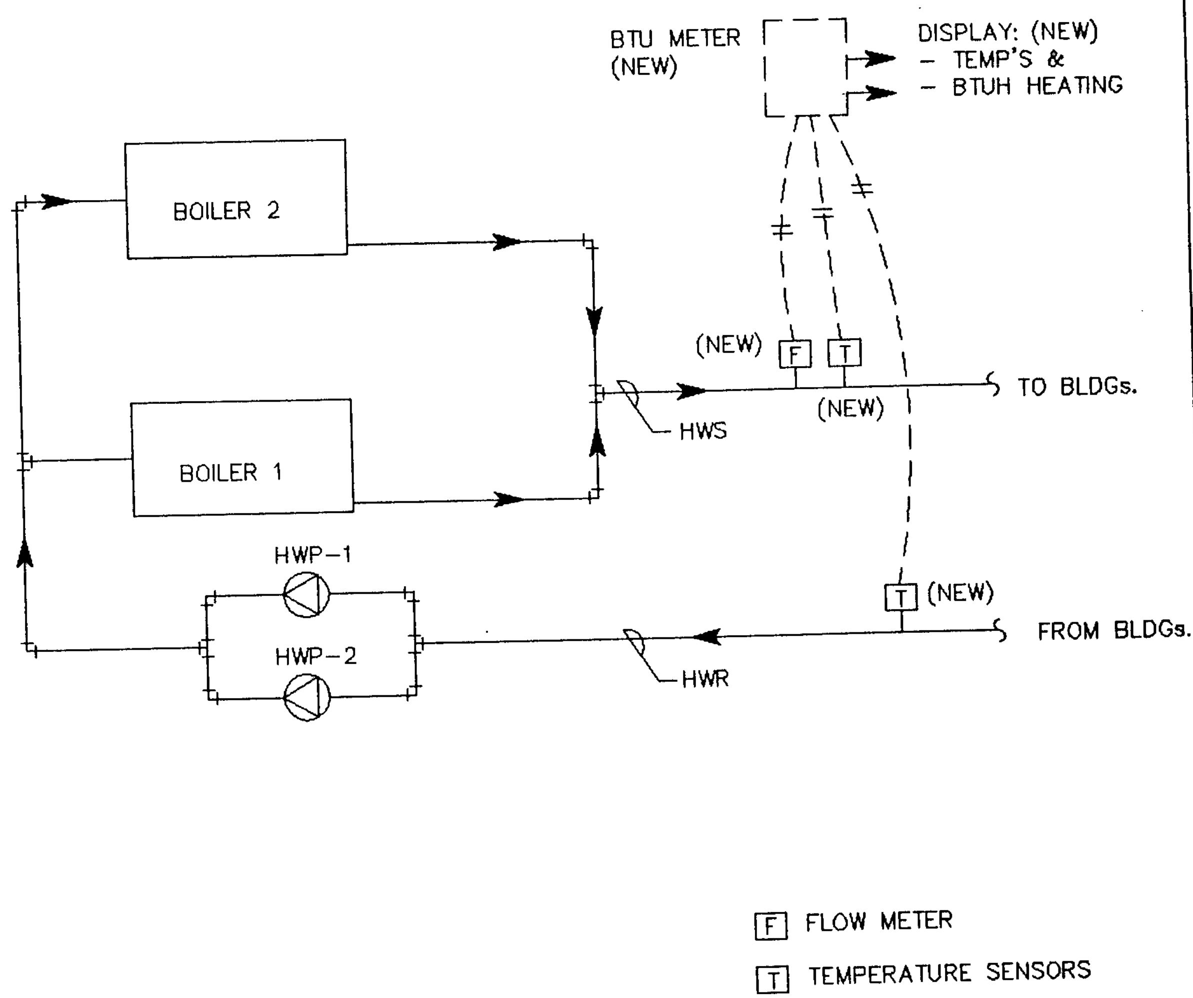
[ECO-SHT.WK3]

BOILER STANDBY SAVINGS

CENTRAL PLANT	BOILER NO.	BOILER TYPE	BOILER MANUFACTURERER	BOILER MODEL NUMBER	RATED BOILER OUTPUT MMBTU/H	CALC. BOILER OUTPUT MMBTU/H	STANDBY LOSS (1%) MMBTU/H	EXCESS STANDBY (HRS/YR)	EXCESS STANDBY MMBTU/H	EXCESS STANDBY SAVINGS ($)
5900	1	HTHW	INTERNATIONAL	D-12	10.00	6.94	0.0694	0		
	2	HTHW	INTERNATIONAL	D-12	10.00	7.17	0.0717	720	51.62	$150.74
	3	HTHW	HERCULES	300	9.70	7.61	0.0761	720	54.82	$160.09
	4	HTHW	HERCULES	300	9.70	7.58	0.0758	720	54.55	$159.27
	5	HTHW	INTERNATIONAL	1035 TH12	8.00	6.22	0.0622	0		
	6	HTHW	INTERNATIONAL	TJW-C-10	11.20	8.88	0.0888	0		
						TOTAL		2160	160.99	$470.10
6003	1	STEAM-12	KEWANEE	L39-350-605	11.72	9.41	0.0941	0		
	2	STEAM-12	YORK SHIPLEY	SPL-350-112080	11.72	9.12	0.0912	0		
	3	STEAM-12	KEWANEE	L36-350-605	11.72	9.37	0.0937	720	67.45	$196.96
						TOTAL		720	67.45	$196.96
730	1	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	0		
	2	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	720	44.34	$129.47
	3	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.18	0.0618	720	44.51	$129.96
	4	STEAM-12	KEWANEE	CAT#7L280-KG-06	2.66	2.11	0.0211	0		
						TOTAL		1440	88.84	$259.43
2812	1	STEAM-12	FEDERAL BOILER CO	GS 3562	1.80	1.40	0.0140	0		
	2	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.77	0.0277	0		
	3	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.86	0.0286	720	20.62	$60.21
						TOTAL		720	20.62	$60.21
5676	1	HW	AMERICAN STANDARD	PF 515	2.44	1.80	0.0180	720	12.93	$37.76
	2	HW	AMERICAN STANDARD	PF 515	2.44	1.71	0.0171	0		
						TOTAL		720	12.93	$37.76
5678	1	HW	BRUNHAM	PF 514	2.27	1.50	0.0150	720	10.79	$31.50
	2	HW	BRUNHAM	PF 514	2.27	1.63	0.0163	0		
						TOTAL		720	10.79	$31.50
914	1	STEAM-12	BRUNHAM	PF-510	1.61	1.29	0.0129	0		
	2	HW	RAY-PAK	EA 200ITB	1.61	1.22	0.0122	0		
	3	HW	AMERICAN STANDARD	G1015	1.92	1.47	0.0147	720	10.56	$30.84
	4	HW	AMERICAN STANDARD	G1015	1.92	1.40	0.0140	0		
						TOTAL		720	10.56	$30.84
4701	1	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	0		
	2	STEAM-100	BIRCHFIELD	FBH 578	11.00	0.00	0.0000	0		
	3	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	720	60.73	$177.33
						TOTAL		720	60.73	$177.33

[BOILERS.WK3]

ECO-7, INSTRUMENTATION FOR BOILER PLANT
(TYPICAL)



[B-ECO-7.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C

[ ] OTHER

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO ; BLDG. 730	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
INSTRUMENTATION TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 4 STEAM BOILERS													
INSERT. FLOW METER	1	EA			197	197			1800.00	1800.00	$1,997		
STM FLOW PROCESSOR	1	EA	6.0	6.0	20	118			695.00	695.00	$813		
SUBTOTAL						$315				$2,495	$2,810		
OVERHEAD, BOND	16%					$50				$399	$450		
PROFIT	10%					$31				$250	$281		
COST SUB-TOTAL						$396				$3,144	$3,540		
CONTINGENCY	20%					$79				$629	$708		
SUBTOTAL						$476				$3,772	$4,248		
S&A	5.5%					$26				$207	$234		
TOTAL THIS SHEET						$502				$3,980	$4,482		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: B730EC1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA — REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER INSTRUMENTATION
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	4248.
B. SIOH	$	234.
C. DESIGN COST	$	255.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	4263.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	4263.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	89.	$ 259.	12.48	3237.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		89.	$ 259.		$ 3237.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) — $ -255.
(1) DISCOUNT FACTOR (TABLE A) — 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) — $ -2323.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -2323.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1068.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 4.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 914.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .21
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 966.12

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 730
ENERGY CONSERVATION OPPORTUNITY: ECO-10
SYSTEM MODIFICATION: OXYGEN TRIM FOR BURNERS
SYSTEMS TO MODIFY: BOILER 1, 2, 3, AND 4

CALCULATION DESCRIPTION:

Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-10, install oxygen trim for burners.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	20,988	20,988
ECO	--	--	20,880	20,880
Savings (Baseline-ECO)	0	0	108	108

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	108 MMBtu/Yr	X	$2.92 /MMBtu	=	$315 per year
Total Energy Cost Savings:	**$0**	+	**$315**	=	**$315 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $2,411 per year

Total: $0 - $2,411 = ($2,411) per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTAL PALNT 730 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	20987.
PEAK DAY GAS CONSUMP., 1000 CU FT	287.
ELECTRICAL CONSUMPTION, KWH	883113.
PEAK KW DEMAND (15 MIN BASIS)	525.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	883113.
ON-PEAK KW DEMAND (15 MIN BASIS)	525.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
BOILER OPERATING HOURS	
BOILER 1	1507
BOILER 2	980
BOILER 3	570
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BOILER ECO-4

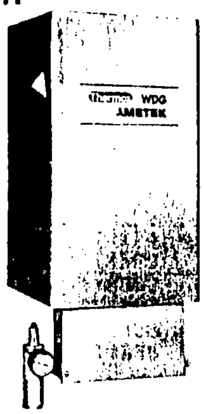
** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING SEASONS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	20880.
PEAK DAY GAS CONSUMP., 1000 CU FT	286.
ELECTRICAL CONSUMPTION, KWH	883026.
PEAK KW DEMAND (15 MIN BASIS)	525.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	883026.
ON-PEAK KW DEMAND (15 MIN BASIS)	525.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
BOILER OPERATING HOURS	
BOILER 1	1506
BOILER 2	974
BOILER 3	562
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

SPECIFICATIONS – AIR-MIZER II SYSTEM

SENSOR



Nominal Dimensions: 14⅝"H x 10¼"W x 10"D (37.2 x 26 x 25.4 cm)

Enclosure: Weather resistant—S.S. case, nickel plated carbon steel base

Weight: 55 pounds (25 kg)

Accuracy: ±1% of net excess oxygen

Repeatability: ±0.2% of measured value

Response: 90% of full scale in less than 5 seconds

Drift: Less than 0.1% of sensor cell output per month

Ambient Temperatures: −5 to +175°F (−20.5 to +79°C)

Sample Temperatures: Up to 1300°F (704°C) with standard probe

Sample Flow Rate: 0.1 to 120 scfh (0.47 to 56.65 liters/minute)

Air Aspirator Requirements: 10 to 20 scfh (4.72 to 14.16 liters/ min) at 15-100 psi (1.05 to 7.037 kg/cm²) (Aspirator air regulator furnished with sensor normally set at 2-7 psi; 0.14 - 0.49 kg/cm²)

Calibration: With analyzed oxygen in nitrogen sample. Calibration port provided.

CONTROL UNIT

Nominal Dimensions: 12⅝"H x 10⅞"W x 9⅛"D (32.1 x 27.6 x 23.2 cm)

Enclosure: Wall/panel mounted—meets the requirements for NEMA 4 areas

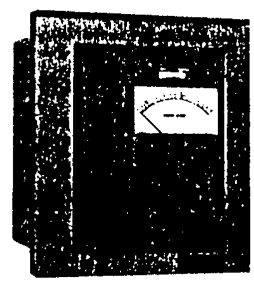
Weight: 22 pounds (10 kg)

Temperature Control: On-Off by microprocessor (±1°C)

Linearization: 256 segments from 20% to 0.2% O_2, (218 from 10% to 0.2%), by microprocessor

Controller Action: On-Off—"On" time adjustable 2-20 seconds. "Off" time adjustable 2-60 seconds.
Deadband: ± 0.25% oxygen.
LED's indicate motor driving.
Will not allow decrease in air when O_2 is below 0.5% oxygen.
Air flow will increase to +15% max. if O_2 level is above 12%.

Setpoint: 0 to 10% oxygen by either of: A. Two banks of 5 slide pots, (Dual Fuel) selectable by slide switch; proper pot or pots connected to processor by switch in actuator. B. Manual pot on panel A or B selected by Remote/Local switch on panel. Setpoint indicated by edge reading meter (0-10%)



Manual Control: Manual/Auto switch and increase—decrease push buttons (Spring return switch inside control unit can override all control actions in the event of processor failure).

Ready Indicator: On at temperature set point. Off below temperature set point. Flashes above temperature set point. O_2 Control in "manual" when below set point.

Oxygen Scale: 20.9 to 0.1% O_2 Logarithmic

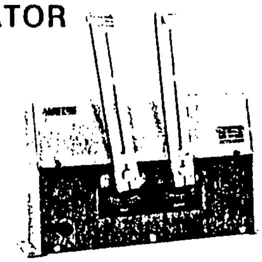
Alarms: High and Low O_2 adjustable 0.2 to 20%. RTD Failure (shuts down temperature control, and puts O_2 control in "manual").

Increase Air Override: Contact closure from optional combustibles or smoke detector alarm will cause increase in air signal on each control pulse regardless or O_2 vs. O_2 setpoint relationship. Once combustibles contact opens, normal control will resume. This maintains air flow at a level where maximum allowable combustibles or smoke is not exceeded.

Ambient Temperature Limits: 32°F to 140°F (0 to +60°C)

Recorder Output: 0-100 mv = 0-20% O_2 Linear (0-50 mv = 0-10%) Other current or voltages outputs optional

ACTUATOR



Overall Size: 17½"L x 4"W x 10¼"H (44.5 x 10.2 x 26 cm)

Weight: 16.5 pounds (7.5 kg)

Angular Travel (Input Arm): 60°

Linear Link Travel: Adjustable 4" to 10" at 4" to 10" Radius (10.2 to 25.4 cm at 10.2 to 25.4 cm Radius)

Linear Link Force: 100 pounds at 4" Radius (45.5 kg at 10.2 cm Radius)
70 pounds at 6" Radius (31.8 kg at 15.2 cm Radius)
40 pounds at 10" Radius (18.2 kg at 25.4 cm Radius)

Case: Suitable for areas requiring NEMA 2 equipment (Drip proof indoor)

Correction: −15% to +15% (.85 to 1.15 gain) of normal air flow

Speed: 60 seconds from −15% to +15% correction (max.)

Load Indication: 9 position shorting switch tied to input arm

Brake: Internal brake will hold load at any above rated force without "coasting"

Ambient Temperature Limits: 0°F to 160°F (−18 to +71°C)

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C
[ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

BOILER ECO BLDG. 730	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
BOILER CONTROL O2 TRIM	No. Of	Unit	MH/	Total	Unit		Unit		Unit			Unit	Total
TASK DESCRIPTION	Units	Meas	Unit	Hrs	Price	Cost	Price	Cost	Price	Cost		Wt	Wt
O2 TRIM CONTROL	3	EA			3000	$9,000			$1,800	$9,590	$18,590		
ANNUAL RECURRING COST													
OXYGEN SENSOR	3	EA	0.5	1.5	24	$36			$420	$1,260	$1,296		
OTHER MAINTENANCE COST	1	LS							$1,115	$1,115	$1,115		
ANNUAL TOTAL											$2,411		
SUBTOTAL						$9,000				$9,590	$18,590		
OVERHEAD, BOND	16.0%					$1,440				$1,534	$2,974		
PROFIT	10.0%					$900				$959	$1,859		
COST SUB-TOTAL						$11,340				$12,083	$23,423		
CONTINGENCY	20.0%					$2,268				$2,417	$4,685		
SUBTOTAL						$13,608				$14,500	$28,108		
S&A	5.5%					$748				$798	$1,546		
TOTAL THIS SHEET						$14,356				$15,298	$29,654		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 730EC10
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER O2 TRIM CONTROL
ANALYSIS DATE: 04-10-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	28108.
B. SIOH	$	1546.
C. DESIGN COST	$	1687.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	28207.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	28207.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	108.	$ 315.	12.48	3936.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		108.	$ 315.		$ 3936.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -2411.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -21964.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -21964.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1299.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -2096.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -18029.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.64
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -13.46

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 730
ENERGY CONSERVATION OPPORTUNITY: ECO- 14
SYSTEM MODIFICATION: NEW CHW PUMP FOR 300 TON CHILLER
SYSTEMS TO MODIFY: CHILLER PLANT

CALCULATION DESCRIPTION:
Hand calculation sheet was prepared to determine the energy savings for ECO-14, install new pump to match load requirements.
It was estimated that the electrical energy can be saved by installing smaller pump to match the load, based on the pump operating hours per year.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	0	144,560	0	493

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	493 MMBtu/Yr	X	$4.0141 /MMBtu	=	$1,980 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$1,980**	+	**$0**	=	**$1,980 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year
= (+) $0 per year

Maintenance: = (-) $0 per year

Total: **$0** - **$0** = **$0 per year**

[ECO-SHT.WK3]

E M C ENGINEERS, INC.
Denver • Colorado Springs • Atlanta • West Germany

JOB: Ft. SILL CENTRAL PLANT 3002.000
SHEET NO. 1 OF 1
CALCULATED BY: KC DATE: 4-3-91
CHECKED BY: CEL DATE: 4-19-91
SCALE: CHILLER ECO

ADDITIONAL PUMP FOR CHILLED WATER DISTRIBUTION SYSTEM, BLDG 730

$$FLOW = \frac{TONs \times 12000}{\Delta T \times 500} = \frac{300 \times 12000}{(53-38) \times 500}$$

FLOW = 480 GPM @ 290 TDH-Ft.

$$BHP = \frac{TDH\text{-}Ft \times GPM}{3960 \times 0.8} = \frac{290 \times 480}{3960 \times 0.8}$$

BHP = 43.94 BHP

$$HP = \frac{BHP}{\%\,EFF\,(PUMP)} = \frac{43.94}{80\%} = 54.9\ HP.$$

$$KW = \frac{HP \times 0.746}{\%\,EFF\,(MOTOR)} = \frac{54.9}{93\%} = 44.1\ KW$$

PEAK COOLING LOAD IS 9.6 MMBtuh (800 TON)

300 TONs CHILLER CAN SUPPLY = 300 × 12000 = 3.6 MMBtuh

$\therefore$ PERCENT OF LOAD IS = $\frac{3.6\ MMBtuh}{9.6\ MMBtuh}$ = 37.5 %

FROM PC-CUBE BASE RUN, HRs @ 37.5 % is 1807 HR.

EXISTING ENERGY USAGE: 150 HP @ 90.23 % EFF

$$KW = \frac{150 \times 0.746}{90.23\%} = 124\ KW$$

NEW ENERGY USAGE: = 44.1 KW

KW SAVING = 124 − 44.1 = 80 KW

\$ SAVING = 80 KW × 1807 HR × 0.0137 \$/KWH = \$ 1980 /YR

OR = 144,560 KWH /YR

OR = 493.4 MMBtu/YR

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 15-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PUMP ECO-14 BLDG. 730	QUANTITY		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
NEW PUMP TO MATCH LOAD / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
600 GPM PUMP	1	EA	7.0	7.0	24	168			700.00	700.00	$868		
PUMP PAD	1	EA							24.00	24.00	$24		
PUMP PIPING CONNECTION	1	EA							450.00	450.00	$450		
PIPING CONNECTION MATERIALS	1	EA	24	24.0	24	576			3000.00	3000.00	$3,576		
60 HP MOTOR INSTALLATION	1	EA	49.0	49.0	24	1175			1800.00	1800.00	$2,975		
MOTOR SETTING	1	EA	5.7	5.7	24	137					$137		
SUBTOTAL						$2,056				$5,974	$8,030		
OVERHEAD, BOND	16.0%					$329				$956	$1,285		
PROFIT	10.0%					$206				$597	$803		
COST SUB-TOTAL						$2,590				$7,527	$10,118		
CONTINGENCY	20.0%					$518				$1,505	$2,024		
SUBTOTAL						$3,108				$9,033	$12,141		
S&A	5.5%					$171				$497	$668		
TOTAL THIS SHEET						$3,279				$9,529	$12,809		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 730EC14
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: PUMP TO MATCH LOAD
ANALYSIS DATE: 04-15-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	12141.
B. SIOH	$	668.
C. DESIGN COST	$	729.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	12184.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	12184.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	493.	$ 1981.	11.37	22519.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		493.	$ 1981.		$ 22519.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 7431.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1981.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 22519.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.85
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 6.15

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 730
ENERGY CONSERVATION OPPORTUNITY: ECO-17
SYSTEM MODIFICATION: DECENTRALIZED BOILERS, ELEC. BOILERS FOR EACH BLDG. DHW
SYSTEMS TO MODIFY: ELECTRICAL WATER HEATERS

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-17, install electric boilers for summer DHW.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	43	144,000	1,582	2,073
ECO	164	192,800	0	658
Savings (Baseline-ECO)	(121)	(48,800)	1,582	1,415

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	-167 MMBtu/Yr	X	$4.0141 /MMBtu	=	($669)per year
Nat. Gas:	1582 MMBtu/Yr	X	$2.92 /MMBtu	=	$4,619 per year
Total Energy Cost Savings:	**($669) +**		**$4,619**	=	**$3,951 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: -121 kW/month X $1.787 /kW X 12 months/year

= (+) ($2,595)per year

Maintenance: = (-) $0 per year

Total: **($2,595)** - **$0** = **($2,595) per year**

[ECO-SHT.WK3]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C

OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 10-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

BOILER ECO BLDG. 730

INSTANT ELECTRIC DHW HEATERS

TASK DESCRIPTION	Quantity: No. Of Units	Quantity: Unit Meas	LABOR: MH/ Unit	LABOR: Total Hrs	LABOR: Unit Price	LABOR: Cost	EQUIPMENT: Unit Price	EQUIPMENT: Cost	MATERIAL: Unit Price	MATERIAL: Cost	TOTAL	SHIPPING: Unit Wt	SHIPPING: Total Wt
BLDG. 700													
20 kW ELECTRIC DHW HEATER	2	EA	10.0	20.0	20	392			1163.00	2326.00	$2,718		
WIRING AND DISCONNECT - 100 AMP	2	EA	8.5	17.0	20	333			247.00	494.00	$827		
50 kVA TRANSFORMER	1	EA	22.9	22.9	20	448			1262.00	1262.00	$1,710		
TRANSFORMER FEEDER SERVICE	1	LS							61.56	61.56	$62		
BLDG. 707													
12 kW ELECTRIC DHW HEATER	2	EA	10.0	20.0	20	392			1163.00	2326.00	$2,718		
WIRING AND DISCONNECT - 100 AMP	2	EA	8.5	17.0	20	333			247.00	494.00	$827		
25 kVA TRANSFORMER	1	EA	16.0	16.0	20	314			806.00	806.00	$1,120		
TRANSFORMER FEEDER SERVICE	1	LS							61.56	61.56	$62		
BLDG. 730													
20 kW ELECTRIC DHW HEATER	3	EA	10.0	30.0	20	588			1163.00	3489.00	$4,077		
WIRING AND DISCONNECT - 100 AMP	3	EA	8.5	25.5	20	500			247.00	741.00	$1,241		
75 kVA TRANSFORMER	1	EA	26.7	26.7	20	523			2830.00	2830.00	$3,353		
TRANSFORMER FEEDER SERVICE	1	LS							61.56	61.56	$62		
BLDG. 840													
20 kW ELECTRIC DHW HEATER	2	EA	10.0	20.0	20	392			1163.00	2326.00	$2,718		
WIRING AND DISCONNECT - 100 AMP	2	EA	8.5	17.0	20	333			247.00	494.00	$827		
50 kVA TRANSFORMER	1	EA	22.9	22.9	20	448			1262.00	1262.00	$1,710		
TRANSFORMER FEEDER SERVICE	1	LS							61.56	61.56	$62		
SUBTOTAL						$4,996				$19,096	$24,092		
OVERHEAD, BOND	16%					$799				$3,055	$3,855		
PROFIT	10%					$500				$1,910	$2,409		
COST SUB-TOTAL						$6,295				$24,061	$30,356		
CONTINGENCY	20%					$1,259				$4,812	$6,071		
SUBTOTAL						$7,554				$28,874	$36,427		
S&A	5.5%					$415				$1,588	$2,003		
TO[illegible]HIS SHEET						$7,969				$30,462	$38,431		

DA FO[illegible]18-R, APR 85

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 730 BASELINE-2

** TOTAL **

SYSTEM C1 OFF SEASON COOLONG, DOMESTIC HW, AND DISTR. LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	1581.
PEAK DAY GAS CONSUMP., 1000 CU FT	12.
ELECTRICAL CONSUMPTION, KWH	145159.
PEAK KW DEMAND (15 MIN BASIS)	130.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	145159.
ON-PEAK KW DEMAND (15 MIN BASIS)	130.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	768
BOILER OPERATING HOURS	
BOILER 1	1810
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Demand Savings: 43 kW for HW pump
164 kW for Electric boiler
Total -121 kW net extra demand

Energy savings(electricity):
Proposed electric boiler consumption -
274 MMBtu/yr DHW load * (1 kWh/.003413 MMBtu) = 80,000 kWh/yr
est. 20 kW aux loads * 1400 hours/yr = 28,000 kWh/yr
Total 108,000 kWh/yr

Existing cooling and HW pump energy 145,000 kWh/yr (see above)
Existing HW pumps only energy, 43kW*1400hrs/yr = 60,200 kWh/yr

Total electrical consumption for ECO 17,
108,000 + 145,000 - 60,200 = 192,800 kWh/yr

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: B730E3B
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ELECTRIC BOILER
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1.	INVESTMENT		
	A. CONSTRUCTION COST	$	36427.
	B. SIOH	$	2004.
	C. DESIGN COST	$	2186.
	D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	36555.
	E. SALVAGE VALUE COST	-$	0.
	F. TOTAL INVESTMENT (1D-1E)	$	36555.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	-167.	$ -670.	11.37	-7622.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	1582.	$ 4619.	17.52	80933.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		1415.	$ 3949.		$ 73311.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -2594.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -30220.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -30220.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 24193.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1355.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 43091.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.18
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 26.98

CENTRAL PLANT 914

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 914
ENERGY CONSERVATION OPPORTUNITY: ECO- 3
SYSTEM MODIFICATION: MINOR RENOVATION & ANNUAL MAINTENANCE
SYSTEMS TO MODIFY: CHILLER 1

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-3, renovate or replace existing chillers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	286	563,000	--	1,922
ECO	193	433,000	--	1,478
Savings (Baseline-ECO)	93	130,000	0	444

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	444 MMBtu/Yr	X	$4.0141 /MMBtu	=	$1,781 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$1,781**	+	**$0**	=	**$1,781 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand:	93 kW/month	X	$1.787 /kW	X	12 months/year
	=	(+)	$1,994 per year		
Maintenance:	=	(-)	$3,000 per year		
Total:	**$1,994**	-	**$3,000**	=	**($1,006) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 914 BASELINE-1

** TOTAL **

SYSTEM C1 COOLING FOR ALL BLDGS AND HEATING FOR BLDG 914

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	13338.
PEAK DAY GAS CONSUMP., 1000 CU FT	126.
ELECTRICAL CONSUMPTION, KWH	563059.
PEAK KW DEMAND (15 MIN BASIS)	286.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	563059.
ON-PEAK KW DEMAND (15 MIN BASIS)	286.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2807
BOILER 3	348
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 914 CHILLER ECO-3

** TOTAL **

SYSTEM C1 HTG FOR 914 & CLG W/ CHILLER IMPROVEMENT TO 90% EFF

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	13338.
PEAK DAY GAS CONSUMP., 1000 CU FT	126.
ELECTRICAL CONSUMPTION, KWH	434224.
PEAK KW DEMAND (15 MIN BASIS)	190.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	434224.
ON-PEAK KW DEMAND (15 MIN BASIS)	190.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2807
BOILER 3	348
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C
[ ] OTHER

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 09-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO-3 BLDG. 914	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
HIGH EFFICIENCY CHILLERS / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CHILLER MAINTENANCE													
400 TON CHILLER MINOR MAINTENANCE	1	LS			1984	1984					$1,984		
SUBTOTAL						$1,984					$1,984		
OVERHEAD, BOND	16%					$317					$317		
PROFIT	10%					$198					$198		
COST SUB-TOTAL						$2,500					$2,500		
CONTINGENCY	20%					$500					$500		
SUBTOTAL						$3,000					$3,000		
S&A	5.5%					$165					$165		
TOTA[illegible]S SHEET						$3,165					$3,165		

DA FORM [illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C914EC3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER MAINTENANCE
ANALYSIS DATE: 04-09-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	3000.
B. SIOH	$	165.
C. DESIGN COST	$	180.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	3011.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	3011.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	444.	$ 1781.	8.78	15637.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	0.	$ 0.	12.48	0.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		444.	$ 1781.		$ 15637.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1006.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -9165.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -9165.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 5160.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 775.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 6473.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 2.15
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 3.88

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 914
ENERGY CONSERVATION OPPORTUNITY: ECO-4
SYSTEM MODIFICATION: INSTALL ICE STORAGE COOLING SYSTEM
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Hand calculation sheet was prepared to determine the energy savings for ECO-4, install ice storage system for HVAC cooling.
It was estimated that the peak electrical demand can be saved by installing ice storage cooling system.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	428	0	0	0

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$0**	**+**	**$0**	**=**	**$0 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 428 kW/month X $1.787 /kW X 12 months/year

= (+) $9,178 per year

Maintenance: = (-) $0 per year

Total: $9,178 - $0 = $9,178 per year

[ECO-SHT.WK3]

A new application of an old idea that can cut air conditioning energy costs in half.

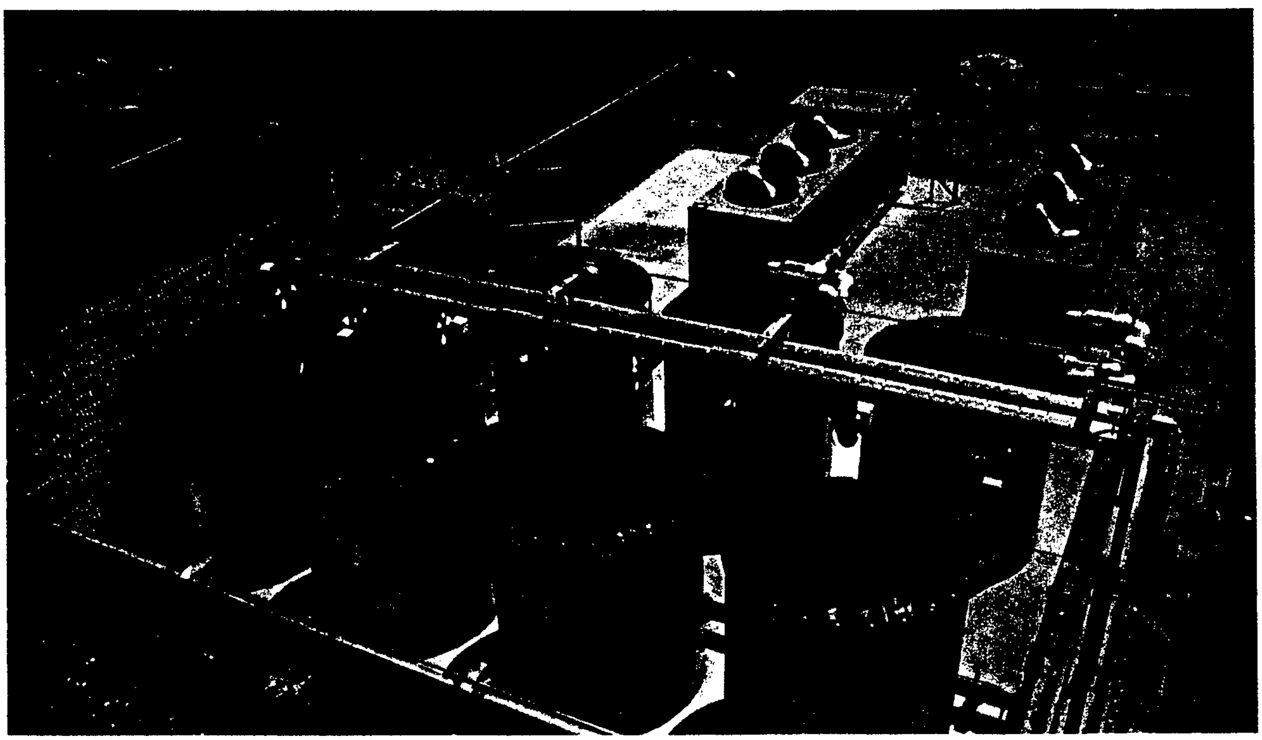
Air conditioning during summer daytime hours is the largest single contributor to utility "peak demand" charges. After noon, as more air conditioners are needed to maintain comfortable temperatures, the increased demand for electricity adds to that already created by lighting, operating equipment, computers and thousands of other uses. This requires the utility to bring additional, more costly generating sources on line to handle its increased demand. Commercial users whose large air conditioning loads contribute to these added generating requirements are assessed an additional charge based on their highest on-peak demand for electricity.

An Ice Bank Stored Cooling System is either a load-shifting or load-leveling method which will significantly lower demand charges during the air conditioning season and, consequently, energy costs. It uses a standard packaged chiller to produce solid ice at night during off-peak periods when the building's electrical needs are at a minimum. The ice is built and stored in modular ice tanks to provide cooling to help meet the building's air conditioning load requirement the following day.

Making ice at night and using its stored energy during the day is not a new or experimental idea. This concept had been employed for years in cooling short-peak applications such as churches and theatres. However, longer peak uses were served by air-source rooftop and chiller-type air conditioners which were less costly to install. Now there is renewed interest in a broad use of ice-making systems by both users and utilities as the best way to offset rising operating costs. In fact, Stored Cooling Systems are what summer-peaking utilities *must have* to avoid the unbearable costs of new generating plants.

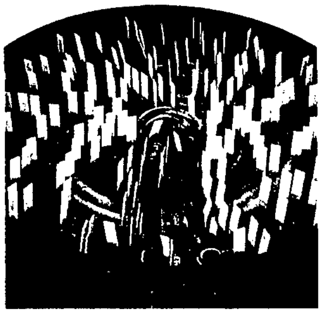
Ice Banks not only can cut operating costs in half but they can also substantially reduce capital outlays when systems are suitably designed for new commercial and industrial buildings. Engineers can specify half-size chillers operating 24 hours a day rather than full-size chillers operating only 10 or 12 hours per day. In retrofit applications, an Ice Bank Stored Cooling System can often provide cooling for an addition to a building without adding chiller capacity.

Atlantic Southern Properties Mays Landing NJ



How the LEVLOAD System Works

The LEVLOAD Ice Bank is a modular, insulated polyethylene tank containing a spiral-wound plastic tube heat exchanger surrounded with water. They are available in four sizes – 90, 100, 190 and 570 ton-hours. At night, a 75 percent water - 25 percent glycol solution from a standard packaged air conditioning chiller circulates through the heat exchanger and extracts heat until eventually all the water in the tank is frozen solid. The ice is built uniformly throughout the tank by the patented temperature-averaging effect of closely spaced counterflow heat exchanger tubes, Figure 5. Water does not become surrounded by ice during the freezing process and can move freely as ice forms, preventing stress or damage to the tank.



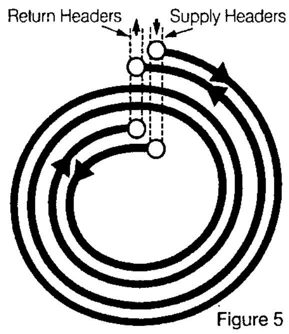


Figure 5

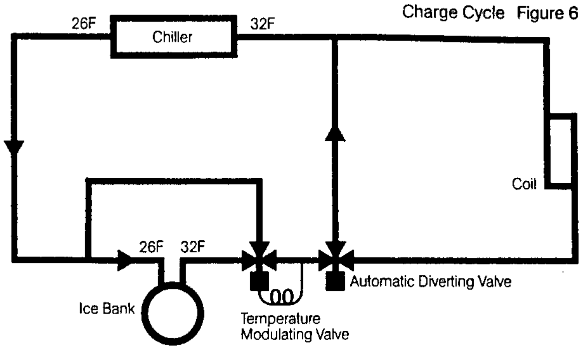
Typical flow diagrams for a Partial Storage System are shown in Figures 6 and 7.

At night, the water-glycol solution circulates through the chiller and the Ice Bank heat exchanger, bypassing the air handler coil. The fluid is at 26F and freezes the water surrounding the heat exchanger.

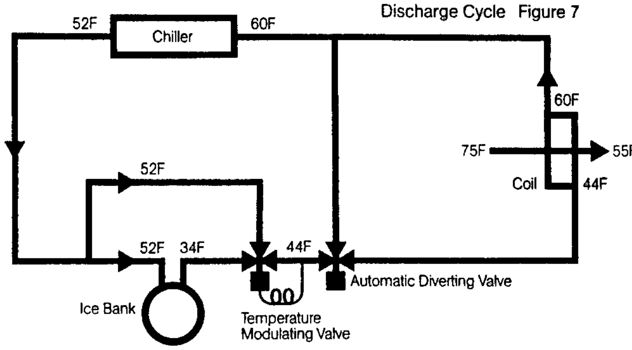
During the day, the solution is cooled by the Ice Bank from 52F to 34F. A temperature modulating valve set at 44F in a bypass loop around the Ice Bank permits a sufficient quantity of 52F fluid to bypass the Ice Bank, mix with the 34F fluid, and achieve the desired 44F temperature. The 44F fluid enters the coil, where it cools air from 75F to 55F. The fluid leaves the coil at 60F, enters the chiller and is cooled to 52F.

It should be noted that, while making ice at night, the chiller must cool the water-glycol solution to 26F, rather than produce 44 or 45F water temperatures required for conventional air conditioning systems. This has the effect of "derating" the nominal chiller capacity by approximately 30 percent. Compressor efficiency, however, is only slightly reduced because lower nighttime temperatures result in cooler condenser water from the cooling tower and help keep the unit operating efficiently. Similarly, air cooled chillers benefit from cooler condenser entering air temperatures at night.

The temperature modulating valve in the bypass loop has the added advantage of providing unlimited capacity control. During many mild temperature days in the spring and fall, the chiller will be capable of providing all the necessary cooling for the building without assistance from stored cooling. When the building's actual cooling load is equal to or lower than the chiller capacity, all of the system coolant flows through the bypass loop, as in Figure 8.



Charge Cycle Figure 6



Discharge Cycle Figure 7

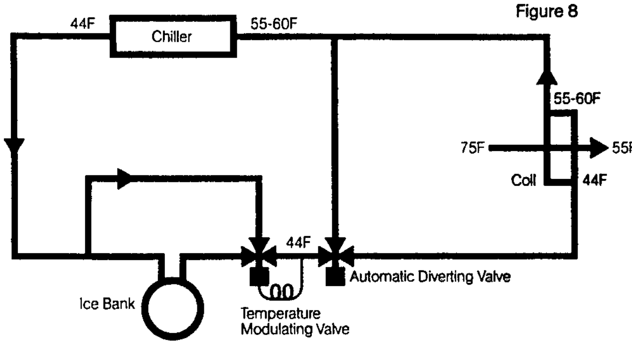


Figure 8

The glycol recommended for the solution is an ethylene glycol-based industrial coolant, such as Dow Chemical Company's Dowtherm® SR-1 or Union Carbide Corporation's UCARTHERM,® which are specially formulated for low viscosity and superior heat transfer properties. These contain a multi-component corrosion inhibitor system which is effective with most materials of construction, including aluminum, copper, solder and plastics. Unlike automotive-type anti-freeze, they produce no films and contain no anti-leak agents to interfere with heat transfer efficiency and permit use of standard system pumps, seals and air handler coils. However, because of the slight difference in heat transfer coefficient between water-glycol and plain water, coil capacity should be increased by approximately 5 percent. It is also important that the water and glycol be thoroughly mixed before the solution enters the system.

LIFE CYCLE COST ANALYSIS SUMMARY   STUDY: 914EC4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)   LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA   REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000   ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991   DISCRETE PORTION NAME: ICE STORAGE COOLING SYSTEM
ANALYSIS DATE: 04-18-91   ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	96000.
B. SIOH	$	5280.
C. DESIGN COST	$	5760.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	96336.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	96336.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 9178.
(1) DISCOUNT FACTOR (TABLE A)   11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 106924.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 106924.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 0.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 9178.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 106924.

6. DISCOUNTED SAVINGS RATIO   (SIR)=(5 / 1F)= 1.11
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4   10.50

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 914
ENERGY CONSERVATION OPPORTUNITY: ECO-5(B)
SYSTEM MODIFICATION: VARIABLE SPEED DRIVE FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO-5, install two-speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	7,148	--	24
ECO	--	4,451	--	15
Savings (Baseline-ECO)	0	2,697	0	9

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	9 MMBtu/Yr	X	$4.0141 /MMBtu	=	$37 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$37**	+	**$0**	=	**$37 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $361 per year

Total: **$0** - **$361** = **($361) per year**

[ECO-SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input. The calculations take into account multi-cell towers (part 7). The control sequence is:

- 0-25% load, fan 1, half speed cycling.
- 25-50% load, fan 1 half speed running, fan 2 half speed cycling:
- 50-75% load, fan 1 full speed cycling, fan 2 half speed running.
- 75-100% load, fan 1 full speed running, fan 2 full speed cycling.

kWh per bin, for % design loads less than 25% load = (fan 1 power kW) * 14% * (%design load / 25) * 4 hours per bin * days per month.

kWh per bin, for % design loads 25% to 50% load = (fan 1 power kW * 14% * 4 hours per bin * days per month) * (fan 2 power kW * 14% * ((% design load - 25)/ 25)* 4 hours per bin * days per month)

kWh per bin, for % design loads 50% to 75% load = (fan 2 power kW * 14% * 4 hours per bin * days per month) * (fan 1 power kW * ((% design load - 50)/ 25) * 4 hours per bin * days per month)

kWh per bin, for % design loads 75% to 100% load = (fan 1 power kW * 4 hours per bin * days per month) + (fan 2 power kW * ((% design load - 75)/ 25) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 914	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	77
– WATER FLOW (gpm)	950
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	3942.5
HEAT REJECTION CAPACITY (Btu/min)	78850
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	40.57
TOTAL ENTHALPY	60.57
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	59532
MOTOR DATA	
– FAN 1 POWER (kW)	8.6
– FAN 2 POWER (kW)	8.6

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET–BULB AVERAGES (4 hour bins)						DESIGN
	1–4	5–8	9–12	13–16	17–20	21–24	WB
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	77
MAY	57.1	56.6	61.2	63.9	63	59.4	77
JUNE	66.8	66.6	69.9	71	70.5	68.2	77
JULY	70.8	70.9	74.5	76	74.9	72.6	77
AUGUST	66.9	67	71	72	71	68.5	77
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	77
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	77

	ENTHALPY FOR AVERAGE WET–BULBS						DESIGN
	1–4	5–8	9–12	13–16	17–20	21–24	ENTHALPY
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	40.57
MAY	24.53	24.21	27.28	29.23	28.57	26.06	40.57
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	40.57
JULY	34.77	34.86	38.14	39.57	38.52	36.37	40.57
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	40.57
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	40.57
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	40.57

COOLING PROFILE OF CENTRAL PLANTS	1-4	5-8	9-12	13-16	17-20	21-24	PEAK LOAD (Btuh)
APRIL	0	0	0	0	0	0	0
MAY	0.3	0.3	0.7	0.7	0.3	0.3	3240000
JUNE	0.3	0.3	0.7	0.7	0.3	0.3	4468000
JULY	0.3	0.3	0.7	0.7	0.3	0.3	4468000
AUGUST	0.3	0.3	0.7	0.7	0.3	0.3	4468000
SEPTEMBER	0.3	0.3	0.7	0.7	0.3	0.3	4468000
OCTOBER	0	0	0	0	0	0	0

RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY	1-4	5-8	9-12	13-16	17-20	21-24	DAYS PER MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	1.8	1.8	1.7	1.6	1.6	1.7	31
JUNE	1.5	1.5	1.3	1.3	1.3	1.4	30
JULY	1.3	1.3	1.1	1.1	1.1	1.2	31
AUGUST	1.5	1.4	1.3	1.2	1.3	1.4	31
SEPTEMBER	1.5	1.5	1.4	1.4	1.4	1.5	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

% DESIGN LOAD	1-4	5-8	9-12	13-16	17-20	21-24	DAYS PER MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	12.1	12.0	30.5	32.4	13.6	12.6	31
JUNE	20.6	20.5	52.7	54.6	23.0	21.4	30
JULY	23.3	23.3	62.4	66.7	27.2	24.8	31
AUGUST	20.7	20.7	54.6	56.6	23.4	21.6	31
SEPTEMBER	19.7	19.6	49.4	50.9	20.9	20.0	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

TWO SPEED COOLING TOWER CYCLING (kWh)	1-4	5-8	9-12	13-16	17-20	21-24	TOTAL (kWh)
APRIL	0	0	0	0	0	0	
MAY	72	71	182	193	81	75	
JUNE	119	119	401	481	133	124	
JULY	139	139	828	1010	162	148	
AUGUST	123	124	497	580	140	129	
SEPTEMBER	114	113	286	328	121	115	
OCTOBER	0	0	0	0	0	0	
TOTAL	567	566	2194	2591	638	592	7148

							TOTAL
	VARIABLE SPEED COOLING TOWER CYCLING (kWh)						(kWh)
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	0	0	0	0	0	0	
MAY	5	5	76	91	7	5	
JUNE	23	22	378	421	31	25	
JULY	34	34	648	790	54	41	
AUGUST	24	24	435	483	34	27	
SEPTEMBER	20	19	312	341	24	21	
OCTOBER	0	0	0	0	0	0	
TOTAL	104	104	1848	2126	150	119	4451

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO BLDG. 914 / VARIABLE SPEED COOLING TOWER	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
VFD FOR TWO 10 HP MOTOR	1	EA	4.0	4.0	20	78			3200.00	3200.00	$3,278		
VFD WIRING & CONNECTION	2	LS	4.1	8.1	20	160			20.00	40.00	$200		
WATER TEMPERATURE SENSOR	1	EA	9.0	9.0	20	176			328.00	328.00	$504		
SUBTOTAL						$414				$3,568	$3,982		
OVERHEAD, BOND	16%					$66				$571	$637		
PROFIT	10%					$41				$357	$398		
COST SUB-TOTAL						$522				$4,496	$5,017		
CONTINGENCY	20%					$104				$899	$1,003		
SUBTOTAL						$626				$5,395	$6,021		
S&A	5.5%					$34				$297	$331		
TOTAL THIS SHEET						$660				$5,692	$6,352		

DA FORM [illegible], APR 85

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: 914EC5B

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.035

INSTALLATION & LOCATION: FT. SILL, OKLAHOMA   REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000   ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991   DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91   ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	6021.
B. SIOH	$	332.
C. DESIGN COST	$	362.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	6044.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	6044.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	9.	$ 37.	11.37	420.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		9.	$ 37.		$ 420.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) — $ -361.
(1) DISCOUNT FACTOR (TABLE A) — 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) — $ -4206.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -4206.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 139.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -324.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -3786.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.63
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -18.65

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 914
ENERGY CONSERVATION OPPORTUNITY: ECO- 6
SYSTEM MODIFICATION: HIGH EFFICIENCY MOTOR REPLACEMENT
SYSTEMS TO MODIFY: PUMP & COOLING TOWER MOTORS

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-6, install high efficiency motors.
It was estimated that the electrical energy can be saved by installing high efficiency motors based on the motor operating hours per year.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	5	8,932	0	30

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	30 MMBtu/Yr	X	$4.0141 /MMBtu =	$122 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu =	$0 per year
Total Energy Cost Savings:	**$122**	**+**	**$0 =**	**$122 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 5 kW/month X $1.787 /kW X 12 months/year

= (+) $107 per year

Maintenance: = (-) $0 per year

Total: **$107** – **$0** = **$107 per year**

[ECO-SHT.WK3]

HIGH EFFICIENCY MOTOR REPLACEMENT

LABOR RATE:	19.6	$/hr
ELECTRIC CONS.	0.0137	$/kWH
ELECTRIC DEMAND	1.787	$/kW

BLDG. NO.	EQUIPMENT SERVE	MOTOR HP	MOTOR FLA	MEAS AMPS	MEAS PF	MEAS VOLT	EXST EFF	NEW EFF	KW SVGS	HRS/ YEAR	KWH/YR SVGS	SVGS/ YEAR
730	CWP-1	150.0	179.0	147.0	0.87	460	90.19%	95.00%	5.73	2641	15120	$330
	CWP-2	150.0	179.0	148.0	0.91	460	86.22%	95.00%	11.50	1873	21539	$542
	CNWP-1	50.0	118.0	107.0	0.98	230	80.97%	93.00%	6.67	2641	17629	$385
	CNWP-2	50.0	118.0	107.0	0.99	230	80.15%	93.00%	7.27	468	3405	$203
	CNWP-3	NI	NI	NI								
	CTM-1	30.0	71.4	70.7	0.93	230	84.60%	92.40%	2.61	702	1834	$81
	CTM-2	30.0	71.4	71.0	0.87	230	90.44%	92.40%	0.58	702	405	$18
	HWP-1	50.0	125.0	117.5	0.87	230	86.10%	93.00%	3.51	3624	12722	$250
	HWP-2	50.0	125.0	118.0	0.87	230	86.10%	93.00%	3.53	3624	12776	$251
		DEMAND CREDIT		$888	MMBtu	292		TOTAL	41		85430	$2,058
914	CWP-1	40.0	48.0	41.3	0.87	460	89.69%	93.00%	1.14	3672	4178	$82
	CNWP-1	15.0	19.0	14.4	0.82	460	90.15%	90.20%	0.01	3672	23	$0
	CTM-1	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	CTM-2	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	HWP-1	2.0	6.2	5.4	0.87	230	69.43%	84.00%	0.47	3624	1694	$33
	HWP-2	2.0	6.2	5.6	0.87	230	69.43%	84.00%	0.48	3624	1757	$34
		DEMAND CREDIT		$111	MMBtu	30		TOTAL	5		8932	$233
2812	CWP-1	20.0	27.0	23.0	0.77	460	90.07%	91.00%	0.16	3672	586	$11
	CNWP-1	25.0	31.5	26.5	0.82	460	91.18%	91.70%	0.11	3672	394	$8
	CTM-1	15.0	18.6	18.6	0.87	460	86.79%	90.20%	0.56	1167	655	$21
	HWP-1	7.5	21.6	18.5	0.87	230	74.74%	88.50%	1.33	5163	6888	$123
	HWP-2	7.5	21.6	19.0	0.87	230	74.74%	88.50%	1.37	3672	5031	$98
		DEMAND CREDIT		$76	MMBtu	46		TOTAL	4		13554	$261
3442	CWP-1	60.0	73.0	63.0	0.84	460	91.62%	94.50%	1.40	3672	5158	$101
	CWP-2	60.0	73.0	63.4	0.84	460	91.62%	94.50%	1.41	3672	5191	$101
	CNWP-1	40.0	52.0	41.0	0.78	460	92.34%	93.00%	0.20	3672	721	$14
	CNWP-2	40.0	52.0	35.8	0.78	460	92.34%	93.00%	0.17	3672	629	$12
	CTM-1	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-2	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-3	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-4	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
		DEMAND CREDIT		$90	MMBtu	44		TOTAL	4		12880	$266
4701	CWP-1	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CWP-2	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CNWP-1	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CNWP-2	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CTM-1	20.0	24.6	18.2	0.87	460	87.50%	91.00%	0.55	650	361	$17
	CTM-2	15.0	19.2	16.5	0.87	440	87.90%	90.20%	0.32	650	206	$10
		DEMAND CREDIT		$65	MMBtu	16		TOTAL	3		4605	$128
5676	HCP-1	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	HCP-2	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	10.5	9	0.79	460	84.66%	88.50%	0.29	1160	337	$11
		DEMAND CREDIT		$94	MMBtu	83		TOTAL	4		24287	$427
5678	HCP-1	2.0	6.5	5.9	0.83	208	76.76%	84.00%	0.20	7296	1445	$24
	HCP-2	2.0	6.5	5.7	0.83	208	76.76%	84.00%	0.19	7296	1396	$23
	HCP-3	1.5	4.8	4.5	0.83	230	70.51%	84.00%	0.34	7296	2474	$41
	HCP-4	2.0	6.3	5.8	0.83	230	71.62%	84.00%	0.39	7296	2878	$48
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	11	9.6	0.75	460	85.12%	88.50%	0.26	1139	293	$10
		DEMAND CREDIT		$64	MMBtu	49		TOTAL	3		14412	$262

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 10-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

[ ] CODE A [X] CODE B [ ] CODE C

[ ] OTHER ____________

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

MOTOR REP. ECO BLDG. 914	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
HIGH EFF. MOTOR REP.LACEMENT / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CWP-1 40.0 HP MOTOR	1	EA	7.2	7.2	20	141			2212.0	2212.00	$2,353		
CNWP-1 15.0 HP MOTOR	1	EA	4.5	4.5	20	88			985.0	985.00	$1,073		
CTM-1 10.0 HP MOTOR	1	EA	3.6	3.6	20	71			750.0	750.00	$821		
CTM-2 10.0 HP MOTOR	1	EA	3.6	3.6	20	71			750.0	750.00	$821		
HWP-1 2.0 HP MOTOR	1	EA	3.2	3.2	20	63			359.0	359.00	$422		
HWP-2 2.0 HP MOTOR	1	EA	3.2	3.2	20	63			359.0	359.00	$422		
SUBTOTAL						$496				$5,415	$5,911		
OVERHEAD, BOND	16%					$79				$866	$946		
PROFIT	10%					$50				$542	$591		
COST SUB-TOTAL						$625				$6,823	$7,448		
CONTINGENCY	20%					$125				$1,365	$1,490		
SUBTOTAL						$750				$8,187	$8,937		
S&A	5.5%					$41				$450	$492		
TOTAL [illegible]S SHEET						$791				$8,638	$9,429		

DA FORM [illegible], APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 914EC6
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: HIGH EFF. MOTOR
ANALYSIS DATE: 04-10-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	8937.
B. SIOH	$	492.
C. DESIGN COST	$	537.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	8969.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	8969.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	31.	$ 122.	11.37	1392.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		31.	$ 122.		$ 1392.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 107.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 1247.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 1247.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 459.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .21
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 229.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2639.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .29
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 39.09

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 914
ENERGY CONSERVATION OPPORTUNITY: ECO-7
SYSTEM MODIFICATION: INSTALL INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-7, install instrumentation to facilitate efficient operation of boiler plant. It was estimated that the energy wasted from boiler in standby is 1% of the rated output capacity. The hours when boilers are running unnecessary were estimated for each boiler.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	0	0	11	11

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	11 MMBtu/Yr	X	$2.92 /MMBtu	=	$32 per year
Total Energy Cost Savings:	**$0**	+	**$32**	=	**$32 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $320 per year

Total: **$0** - **$320** = **($320) per year**

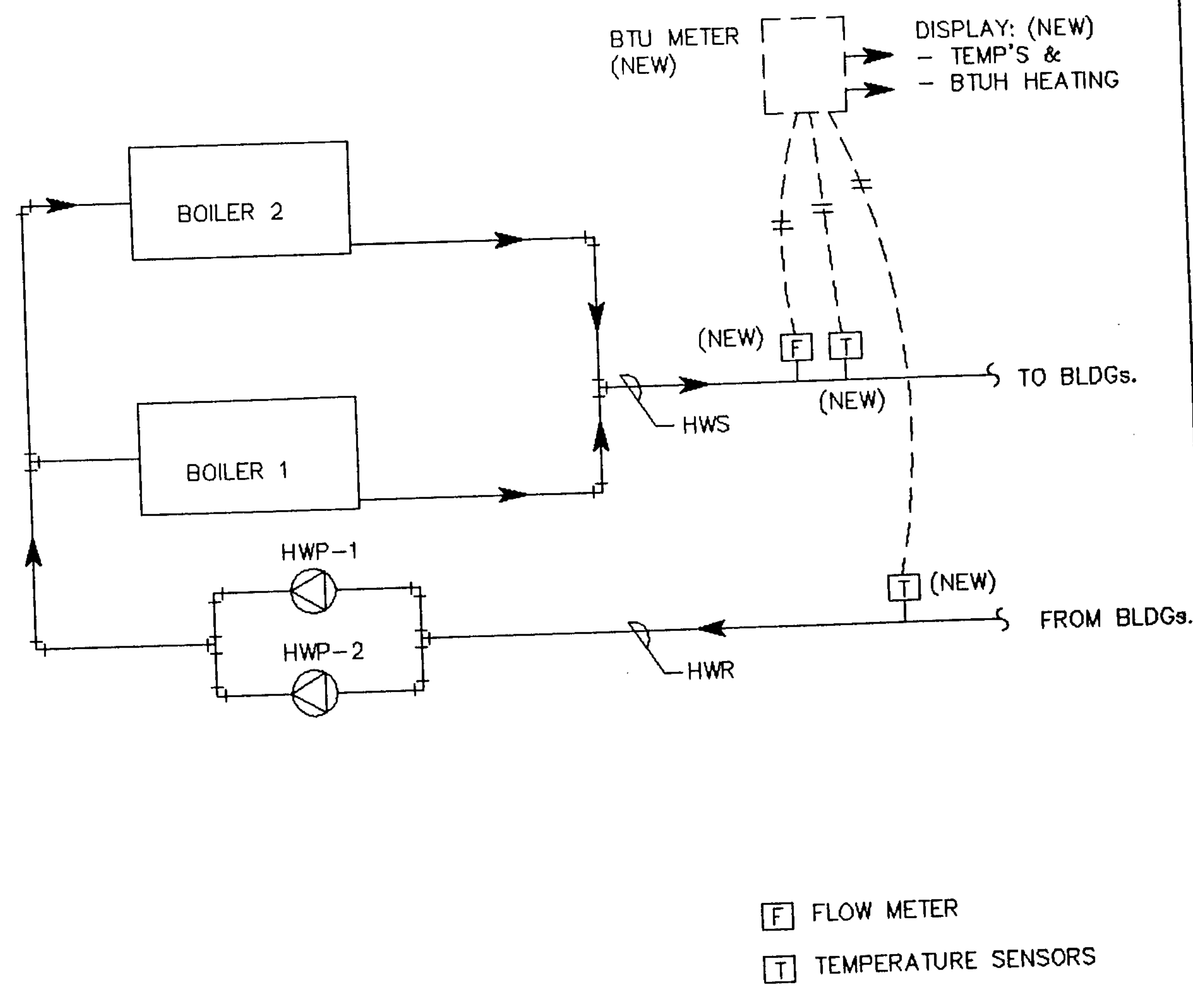
[ECO-SHT.WK3]

BOILER STANDBY SAVINGS

CENTRAL PLANT	BOILER NO.	BOILER TYPE	BOILER MANUFACTURERER	BOILER MODEL NUMBER	RATED BOILER OUTPUT MMBTU/H	CALC. BOILER OUTPUT MMBTU/H	STANDBY LOSS (1%) MMBTU/H	EXCESS STANDBY (HRS/YR)	EXCESS STANDBY MMBTU/H	EXCESS STANDBY SAVINGS ($)
5900	1	HTHW	INTERNATIONAL	D-12	10.00	6.94	0.0694	0		
	2	HTHW	INTERNATIONAL	D-12	10.00	7.17	0.0717	720	51.62	$150.74
	3	HTHW	HERCULES	300	9.70	7.61	0.0761	720	54.82	$160.09
	4	HTHW	HERCULES	300	9.70	7.58	0.0758	720	54.55	$159.27
	5	HTHW	INTERNATIONAL	1035 TH12	8.00	6.22	0.0622	0		
	6	HTHW	INTERNATIONAL	TJW-C-10	11.20	8.88	0.0888	0		
						TOTAL		2160	160.99	$470.10
6003	1	STEAM-12	KEWANEE	L39-350-605	11.72	9.41	0.0941	0		
	2	STEAM-12	YORK SHIPLEY	SPL-350-112080	11.72	9.12	0.0912	0		
	3	STEAM-12	KEWANEE	L36-350-605	11.72	9.37	0.0937	720	67.45	$196.96
						TOTAL		720	67.45	$196.96
730	1	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	0		
	2	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	720	44.34	$129.47
	3	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.18	0.0618	720	44.51	$129.96
	4	STEAM-12	KEWANEE	CAT#7L280-KG-06	2.66	2.11	0.0211	0		
						TOTAL		1440	88.84	$259.43
2812	1	STEAM-12	FEDERAL BOILER CO	GS 3562	1.80	1.40	0.0140	0		
	2	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.77	0.0277	0		
	3	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.86	0.0286	720	20.62	$60.21
						TOTAL		720	20.62	$60.21
5676	1	HW	AMERICAN STANDARD	PF 515	2.44	1.80	0.0180	720	12.93	$37.76
	2	HW	AMERICAN STANDARD	PF 515	2.44	1.71	0.0171	0		
						TOTAL		720	12.93	$37.76
5678	1	HW	BRUNHAM	PF 514	2.27	1.50	0.0150	720	10.79	$31.50
	2	HW	BRUNHAM	PF 514	2.27	1.63	0.0163	0		
						TOTAL		720	10.79	$31.50
914	1	STEAM-12	BRUNHAM	PF-510	1.61	1.29	0.0129	0		
	2	HW	RAY-PAK	EA 200ITB	1.61	1.22	0.0122	0		
	3	HW	AMERICAN STANDARD	G1015	1.92	1.47	0.0147	720	10.56	$30.84
	4	HW	AMERICAN STANDARD	G1015	1.92	1.40	0.0140	0		
						TOTAL		720	10.56	$30.84
4701	1	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	0		
	2	STEAM-100	BIRCHFIELD	FBH 578	11.00	0.00	0.0000	0		
	3	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	720	60.73	$177.33
						TOTAL		720	60.73	$177.33

[BOILERS.WK3]

ECO-7, INSTRUMENTATION FOR BOILER PLANT
(TYPICAL)



[B-ECO-7.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO BLDG. 914	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
INSTRUMENTATION / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 3 HW BOILERS													
INSERT. FLOW METER	1	EA			197	197			764.00	764.00	$961		
HWS TEMPERATURE SENSOR	1	EA			176	176			328.00	328.00	$504		
HWR TEMPERATURE SENSOR	1	EA			176	176			328.00	328.00	$504		
BTU METER	1	EA	6.0	6.0	20	118			820.00	820.00	$938		
LED DISPLAY	2	EA							60.00	120.00	$120		
LED INSTALLATION	2	EA	4.6	9.2	20	180			158.00	316.00	$496		
SUBTOTAL						$847				$2,676	$3,523		
OVERHEAD, BOND	16%					$136				$428	$564		
PROFIT	10%					$85				$268	$352		
COST SUB-TOTAL						$1,067				$3,372	$4,439		
CONTINGENCY	20%					$213				$674	$888		
SUBTOTAL						$1,281				$4,046	$5,327		
S&A	5.5%					$70				$223	$293		
TOTAL THIS SHEET						$1,351				$4,269	$5,620		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: B914EC1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOM REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER INSTRUMENTATION
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	5327.
B. SIOH	$	293.
C. DESIGN COST	$	320.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	5346.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	5346.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	11.	$ 31.	12.48	385.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		11.	$ 31.		$ 385.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -320.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -2915.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -2915.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 127.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -289.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -2530.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.47
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -18.49

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 914
ENERGY CONSERVATION OPPORTUNITY: ECO-8
SYSTEM MODIFICATION: BOILER OPTIMIZATION, CONTROL & INSTRUMENTATION
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-8, install instrumentation connected to EMCS for boiler optimization. It was estimated that the energy wasted from boiler in standby is 1% of the rated output capacity. The hours when boilers are running unnecessary were estimated for each boiler.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	13,338	13,338
ECO	--	--	13,294	13,294
Savings (Baseline-ECO)	0	0	44	44

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	44 MMBtu/Yr	X	$2.92 /MMBtu	=	$128 per year
Total Energy Cost Savings:	**$0**	+	**$128**	=	**$128 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $2,031 per year

Total: **$0** - **$2,031** = **($2,031) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 914 BASELINE-1

** TOTAL **

SYSTEM C1 COOLING FOR ALL BLDGS AND HEATING FOR BLDG 914

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	13338.
PEAK DAY GAS CONSUMP., 1000 CU FT	126.
ELECTRICAL CONSUMPTION, KWH	563059.
PEAK KW DEMAND (15 MIN BASIS)	286.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	563059.
ON-PEAK KW DEMAND (15 MIN BASIS)	286.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2807
BOILER 3	348
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

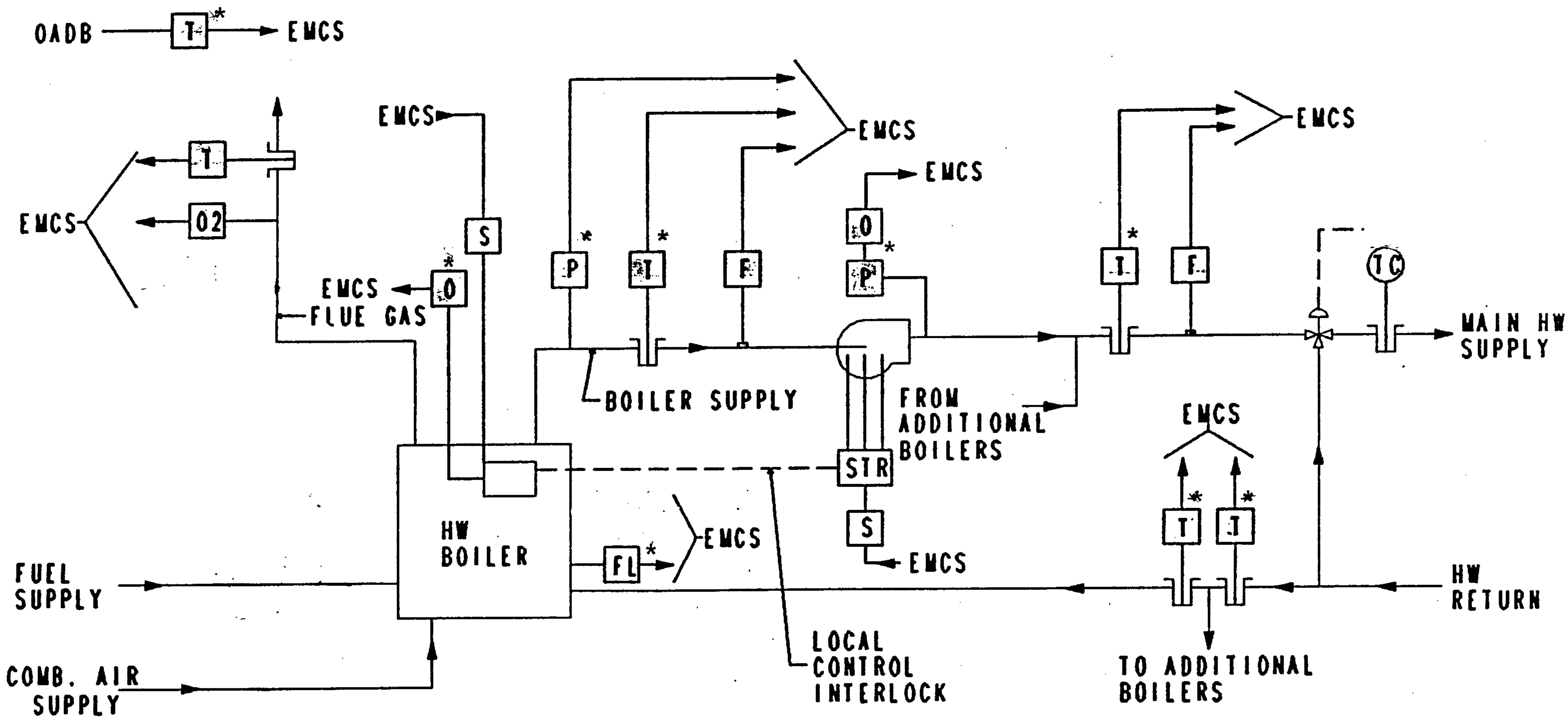
PC-CUBE VERSION 2.0.3

CENTRAL PLANT 914 BOILER ECO-8

** TOTAL **

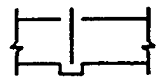
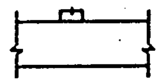
SYSTEM C1 COOLING FOR ALL BLDGS AND HEATING FOR BLDG 914

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	13293.
PEAK DAY GAS CONSUMP., 1000 CU FT	125.
ELECTRICAL CONSUMPTION, KWH	563059.
PEAK KW DEMAND (15 MIN BASIS)	286.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	563059.
ON-PEAK KW DEMAND (15 MIN BASIS)	286.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2807
BOILER 3	1398
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.



Hot water boiler

* - Points included on proposed EMCS design, existing.
All other points are new.

Symbol	Meaning
→ EMCS	SIGNAL TRANSMITTED TO EMCS
← EMCS	SIGNAL TRANSMITTED FROM EMCS
$\boxed{A}$	ALARM CONTACT SIGNAL
$\boxed{E}$	ECONOMIZER CONTROL INTERFACE
$\boxed{F}$	FLOW INDICATION
$\boxed{FL}$	FLAME INDICATION
$\boxed{H}$	HUMIDITY INDICATION
$\boxed{P}$	PRESSURE INDICATION
$\boxed{LV}$	LEVEL INDICATION
$\boxed{M}$	METER
$\boxed{O}$	ON-OFF STATUS SIGNAL
$\boxed{DP}$	DIFFERENTIAL PRESSURE SWITCH
$\boxed{R}$	CONTROLLER RESET INTERFACE
$\boxed{S}$	START-STOP INTERFACE
$\boxed{T}$	TEMPERATURE INDICATION
$\boxed{V}$	VENTILATION/RECIRCULATION CONTROL
$\boxed{PS}$	POSITION
$\boxed{O_2}$	FLUE GAS ANALYSIS, OXYGEN
$\boxed{Co}$	FLUE GAS ANALYSIS, CARBON MONOXIDE
$\boxed{FD}$	FURNACE DRAFT DIFFERENTIAL PRESSURE
$\boxed{DS}$	HIGH-LOW DEMAND SIGNAL SELECTOR
TC	TEMPERATURE CONTROLLER
PC	PRESSURE CONTROLLER
$\boxed{STR}$	MOTOR STARTER
	SENSOR INSTALLED IN THERMOMETER WELL
	SENSOR INSTALLED IN DUCT OR PLENUM
CHW	CHILLED WATER
EA	EXHAUST AIR
SA	SUPPLY AIR
RA	RETURN AIR
OA	OUTSIDE AIR
MA	MIXED AIR
WB	WET BULB
DB	DRY BULB
OAD	OUTSIDE AIR DAMPER
RAD	RETURN AIR DAMPER
EAD	EXHAUST AIR DAMPER
MZD	MULTIZONE DAMPER
RH	RELATIVE HUMIDITY

Symbols and Abbreviations

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.	DACA 59-90-C-0087
CODE A [X] CODE B [ ] CODE C [ ] OTHER	
EFFECTIVE PRICING DATE	APR. 91
DATE PREPARED	18-Apr-91
DRAWING NO.	
SHT	OF
ESTIMATOR	KC
CHECKED BY	CEL
PROJECT	ENERGY SURVEY OF ARMY BOILER AND CHILLER
LOCATION	FT. SILL, OKLAHOMA

BOILER ECO BLDG. 914	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
OPTIMIZE BOILER SEQUENCE / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 3 HW BOILERS													
HWS TEMPERATURE SENSOR	3	EA			176	$528			$328	$984	$1,512		
HWR TEMPERATURE SENSOR	3	EA			176	$528			$328	$984	$1,512		
HWP ST/SP	2	LS			39	$78			$226	$452	$530		
DP (LIQUID) PUMP STATUS	2	LS			155	$310			$205	$410	$720		
BOILER ST/SP	3	EA	2.0	6.0	20	$118			$226	$678	$796		
FID PANEL & ACCESSORIES	1	LS			208	$208			$3,681	$3,681	$3,889		
FID SOFTWARE COMMISSIONING	1	EA	6.0	6.0	45	$270					$270		
FID TESTING	1	EA	6	6	45	270					$270		
INST. FLOW METER	1	EA	3.5	3.5	20	$69			500	$500	$569		
STACK O2 SENSOR	3	LS			338	$1,014			$3,483	$10,449	$11,463		
STACK TEMP. SENSOR	3	EA	4.0	12.0	20	$235			$207	$620	$855		
SUBTOTAL						$3,628				$18,758	$22,385		
OVERHEAD, BOND	16.0%					$580				$3,001	$3,582		
PROFIT	10.0%					$363				$1,876	$2,239		
COST SUB-TOTAL						$4,571				$23,634	$28,205		
CONTINGENCY	20.0%					$914				$4,727	$5,641		
SUBTOTAL						$5,485				$28,361	$33,847		
S&A	5.5%					$302				$1,560	$1,862		
TOTAL THIS SHEET						$5,787				$29,921	$35,708		

DA FOR[illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: B914EC12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER OPTIMIZATION
ANALYSIS DATE: 04-18-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	33847.
B. SIOH	$	1862.
C. DESIGN COST	$	2031.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	33966.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	33966.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	44.	$ 128.	12.48	1603.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		44.	$ 128.		$ 1603.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -2031.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -18502.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -18502.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 529.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -1903.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -16899.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.50
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -17.85

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 914
ENERGY CONSERVATION OPPORTUNITY: ECO-9
SYSTEM MODIFICATION: RENOVATE BOILERS
SYSTEMS TO MODIFY: BOILER 2, 3, AND 4

CALCULATION DESCRIPTION:

Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-9, renovate or replace existing boilers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	13,338	13,338
ECO	--	--	12,838	12,838
Savings (Baseline-ECO)	0	0	500	500

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	500 MMBtu/Yr	X	$2.92 /MMBtu	=	$1,460 per year
Total Energy Cost Savings:	**$0**	+	**$1,460**	=	**$1,460 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $3,000 per year

Total: **$0** - **$3,000** = **($3,000) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 914 BASELINE-1

** TOTAL **

SYSTEM C1 COOLING FOR ALL BLDGS AND HEATING FOR BLDG 914

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	13338.
PEAK DAY GAS CONSUMP., 1000 CU FT	126.
ELECTRICAL CONSUMPTION, KWH	563059.
PEAK KW DEMAND (15 MIN BASIS)	286.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	563059.
ON-PEAK KW DEMAND (15 MIN BASIS)	286.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2807
BOILER 3	348
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 914 BOILER ECO-9

** TOTAL **

SYSTEM C1 COOLING FOR ALL BLDGS AND HEATING FOR BLDG 914

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	12837.
PEAK DAY GAS CONSUMP., 1000 CU FT	121.
ELECTRICAL CONSUMPTION, KWH	563059.
PEAK KW DEMAND (15 MIN BASIS)	286.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	563059.
ON-PEAK KW DEMAND (15 MIN BASIS)	286.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2785
BOILER 3	256
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 18-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CODE A [X] CODE B [ ] CODE C [ ] OTHER

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO BLDG. 914	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
BOILER RENOVATION TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
RENOVATION OF BOILERS													
CLEAN TUBES	3	EA	16.0	48.0	24	$1,152					$1,152		
REBUILD REFACTORY	3	EA	40.0	120.0	24	$2,880					$2,880		
NEW INSULATION	3	LS							$1,920	$5,760	$5,760		
ADJUST CONTROLS	3	EA	6.7	20.0	24	$480					$480		
ACIDIZING	3	EA	6.7	20.0	24	$480					$480		
CLEAN ADJUST BURNERS	3	EA	4.0	12.0	24	$288					$288		
TEST BOILERS	3	EA	4.0	12.0	24	$288					$288		
NEW INSTRUMENTS	3	LS							$200	$600	$600		
ANNUAL RECURRING COST													
CLEAN TUBES	3	EA	16.0	48.0	24	$1,152					$1,152		
ADJUST CONTROLS	3	EA	6.7	20.0	24	$480					$480		
ACIDIZING	3	EA	6.7	20.0	24	$480					$480		
CLEAN ADJUST BURNERS	3	EA	4.0	12.0	24	$288					$288		
TEST BOILERS	3	EA	4.0	12.0	24	$288					$288		
TOTAL											$2,688		
SUBTOTAL						$5,568				$6,360	$11,928		
OVERHEAD, BOND	16.0%					$891				$1,018	$1,908		
PROFIT	10.0%					$557				$636	$1,193		
COST SUB-TOTAL						$7,016				$8,014	$15,029		
CONTINGENCY	20.0%					$1,403				$1,603	$3,006		
SUBTOTAL						$8,419				$9,616	$18,035		
S&A	5.5%					$463				$529	$992		
TOTAL THIS SHEET (WO/ANNUAL RECC. COST)						$8,882				$10,145	$19,027		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: B914EC3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER RENOVATION
ANALYSIS DATE: 04-18-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	18035.
B. SIOH	$	992.
C. DESIGN COST	$	1082.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	18098.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	18098.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	500.	$ 1460.	17.52	25579.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		500.	$ 1460.		$ 25579.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -3000.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -34950.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -34950.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 8441.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -1540.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -9371.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.52
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -11.75

CENTRAL PLANT 2812

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 2812
ENERGY CONSERVATION OPPORTUNITY: ECO-3
SYSTEM MODIFICATION: REPLACE EXISTING CHILLER
SYSTEMS TO MODIFY: CHILLER 1

CALCULATION DESCRIPTION:

Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-3, renovate or replace existing chillers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	192	480,000	--	1,638
ECO	150	408,000	--	1,393
Savings (Baseline-ECO)	42	72,000	0	246

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 246 MMBtu/Yr X $4.0141 /MMBtu = $986 per year

Nat. Gas: 0 MMBtu/Yr X $2.92 /MMBtu = $0 per year

Total Energy Cost Savings: $986 + $0 = $986 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 42 kW/month X $1.787 /kW X 12 months/year

= (+) $901 per year

Maintenance: = (-) $3,000 per year

Total: $901 - $3,000 = ($2,099) per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

** TOTAL **

SYSTEM C1 HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	27450.
PEAK DAY GAS CONSUMP., 1000 CU FT	237.
ELECTRICAL CONSUMPTION, KWH	479788.
PEAK KW DEMAND (15 MIN BASIS)	192.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	479788.
ON-PEAK KW DEMAND (15 MIN BASIS)	192.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3027
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 CHILLER ECO-3

** TOTAL **

SYSTEM C1 HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	27450.
PEAK DAY GAS CONSUMP., 1000 CU FT	237.
ELECTRICAL CONSUMPTION, KWH	407782.
PEAK KW DEMAND (15 MIN BASIS)	150.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	407782.
ON-PEAK KW DEMAND (15 MIN BASIS)	150.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3027
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 09-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO-3 BLDG. 2812	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
HIGH EFFICIENCY CHILLERS TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CHILLER REPLACEMENT													
170 TON CHILLER	1	LS	56.0	56.0	24	1344	550	550	56731.00	56731.00	$58,625		
REMOVE EXISTING CHILLER	1	LS	36.0	36.0	24	864					$864		
SUBTOTAL						$2,208		$550		$56,731	$59,489		
OVERHEAD, BOND	16%					$353		$88		$9,077	$9,518		
PROFIT	10%					$221		$55		$5,673	$5,949		
COST SUB-TOTAL						$2,782		$693		$71,481	$74,956		
CONTINGENCY	20%					$556		$139		$14,296	$14,991		
SUBTOTAL						$3,338		$832		$85,777	$89,947		
S&A	5.5%					$184		$46		$4,718	$4,947		
TOTAL THIS SHEET						$3,522		$877		$90,495	$94,894		

DA FORM [illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C2812EC3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER REPLACEMENT
ANALYSIS DATE: 04-09-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	89947.
B. SIOH	$	4947.
C. DESIGN COST	$	5397.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	90262.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	90262.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	246.	$ 986.	11.37	11216.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		246.	$ 986.		$ 11216.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -2099.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -24453.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -24453.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3701.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -1113.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -13238.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.15
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -81.13

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 2812
ENERGY CONSERVATION OPPORTUNITY: ECO-4
SYSTEM MODIFICATION: INSTALL ICE STORAGE COOLING SYSTEM
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Hand calculation sheet was prepared to determine the energy savings for ECO-4, install ice storage system for HVAC cooling.
It was estimated that the peak electrical demand can be saved by installing ice storage cooling system.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas (MMBtu)	Total Energy (MMBtu)
	Demand(kW)	Energy(kWh)		
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	301	0	0	0

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$0**	**+**	**$0**	**=**	**$0 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand:	301 kW/month	X	$1.787 /kW	X	12 months/year
	=	(+)	$6,455 per year		
Maintenance:	=	(-)	$0 per year		
Total:	**$6,455**	**-**	**$0**	**=**	**$6,455 per year**

[ECO-SHT.WK3]

A new application of an old idea that can cut air conditioning energy costs in half.

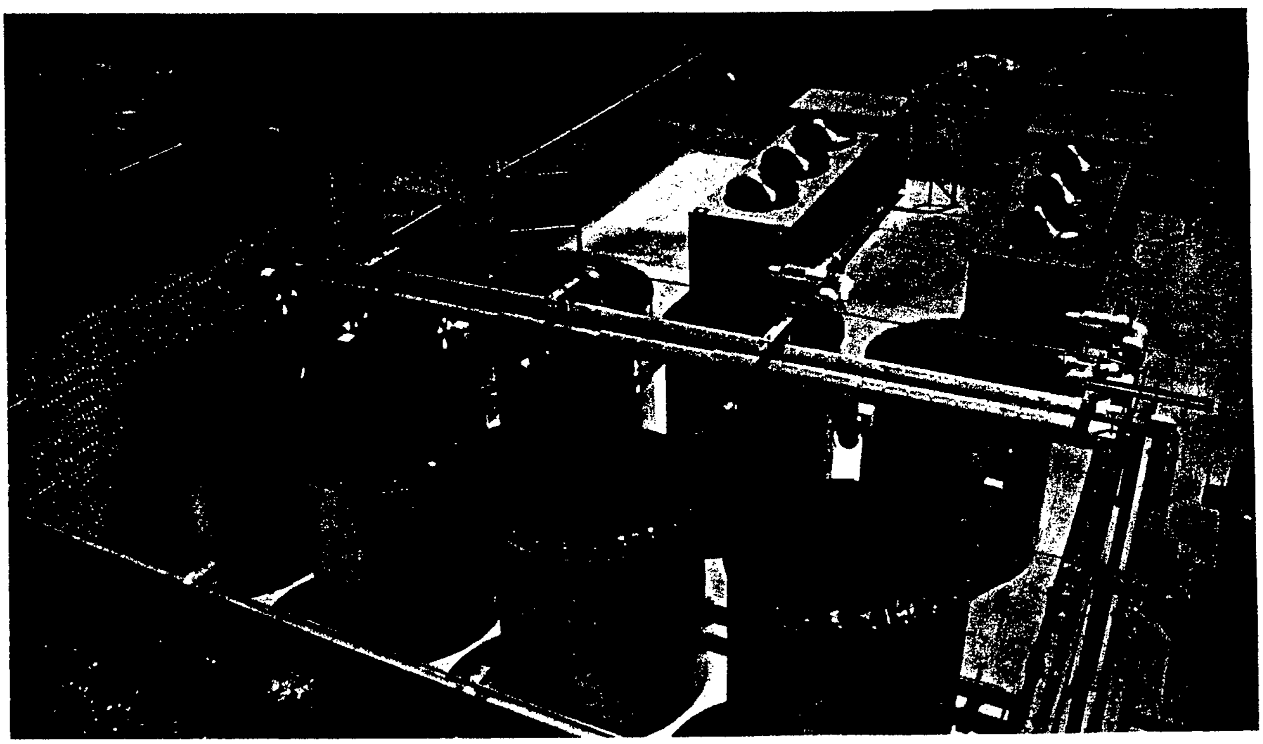
Air conditioning during summer daytime hours is the largest single contributor to utility "peak demand" charges. After noon, as more air conditioners are needed to maintain comfortable temperatures, the increased demand for electricity adds to that already created by lighting, operating equipment, computers and thousands of other uses. This requires the utility to bring additional, more costly generating sources on line to handle its increased demand. Commercial users whose large air conditioning loads contribute to these added generating requirements are assessed an additional charge based on their highest on-peak demand for electricity.

An Ice Bank Stored Cooling System is either a load-shifting or load-leveling method which will significantly lower demand charges during the air conditioning season and, consequently, energy costs. It uses a standard packaged chiller to produce solid ice at night during off-peak periods when the building's electrical needs are at a minimum. The ice is built and stored in modular ice tanks to provide cooling to help meet the building's air conditioning load requirement the following day.

Making ice at night and using its stored energy during the day is not a new or experimental idea. This concept had been employed for years in cooling short-peak applications such as churches and theatres. However, longer peak uses were served by air-source rooftop and chiller-type air conditioners which were less costly to install. Now there is renewed interest in a broad use of ice-making systems by both users and utilities as the best way to offset rising operating costs. In fact, Stored Cooling Systems are what summer-peaking utilities *must have* to avoid the unbearable costs of new generating plants.

Ice Banks not only can cut operating costs in half but they can also substantially reduce capital outlays when systems are suitably designed for new commercial and industrial buildings. Engineers can specify half-size chillers operating 24 hours a day rather than full-size chillers operating only 10 or 12 hours per day. In retrofit applications, an Ice Bank Stored Cooling System can often provide cooling for an addition to a building without adding chiller capacity.

Atlantic Southern Properties Mays Landing NJ



D-2812-7

How the LEVLOAD System Works

The LEVLOAD Ice Bank is a modular, insulated polyethylene tank containing a spiral-wound plastic tube heat exchanger surrounded with water. They are available in four sizes – 90, 100, 190 and 570 ton-hours. At night, a 75 percent water - 25 percent glycol solution from a standard packaged air conditioning chiller circulates through the heat exchanger and extracts heat until eventually all the water in the tank is frozen solid. The ice is built uniformly throughout the tank by the patented temperature-averaging effect of closely spaced counterflow heat exchanger tubes, Figure 5. Water does not become surrounded by ice during the freezing process and can move freely as ice forms, preventing stress or damage to the tank.

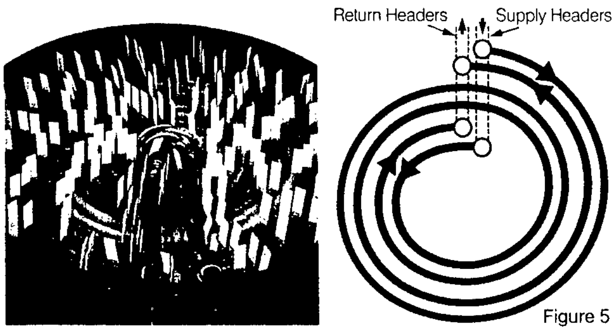


Figure 5

Typical flow diagrams for a Partial Storage System are shown in Figures 6 and 7.

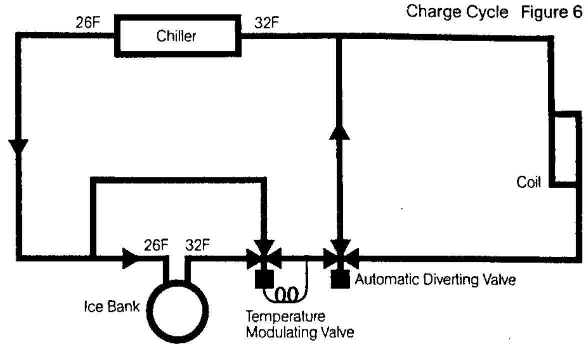
At night, the water-glycol solution circulates through the chiller and the Ice Bank heat exchanger, bypassing the air handler coil. The fluid is at 26F and freezes the water surrounding the heat exchanger.

During the day, the solution is cooled by the Ice Bank from 52F to 34F. A temperature modulating valve set at 44F in a bypass loop around the Ice Bank permits a sufficient quantity of 52F fluid to bypass the Ice Bank, mix with the 34F fluid, and achieve the desired 44F temperature. The 44F fluid enters the coil, where it cools air from 75F to 55F. The fluid leaves the coil at 60F, enters the chiller and is cooled to 52F.

It should be noted that, while making ice at night, the chiller must cool the water-glycol solution to 26F, rather than produce 44 or 45F water temperatures required for conventional air conditioning systems. This has the effect of "derating" the nominal chiller capacity by approximately 30 percent. Compressor efficiency, however, is only slightly reduced because lower nighttime temperatures result in cooler condenser water from the cooling tower and help keep the unit operating efficiently. Similarly, air cooled chillers benefit from cooler condenser entering air temperatures at night.

The temperature modulating valve in the bypass loop has the added advantage of providing unlimited capacity control. During many mild temperature days in the spring and fall, the chiller will be capable of providing all the necessary cooling for the building without assistance from stored cooling. When the building's actual cooling load is equal to or lower than the chiller capacity, all of the system coolant flows through the bypass loop, as in Figure 8.

Charge Cycle Figure 6



Discharge Cycle Figure 7

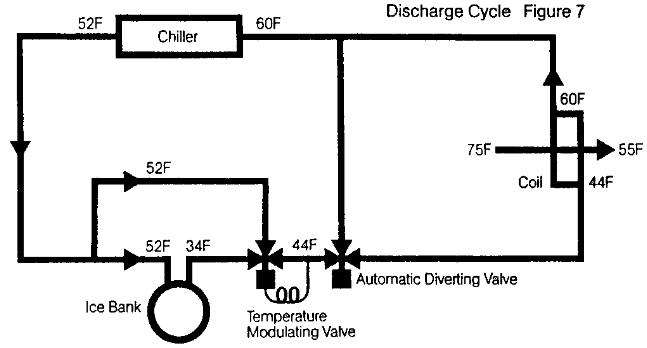
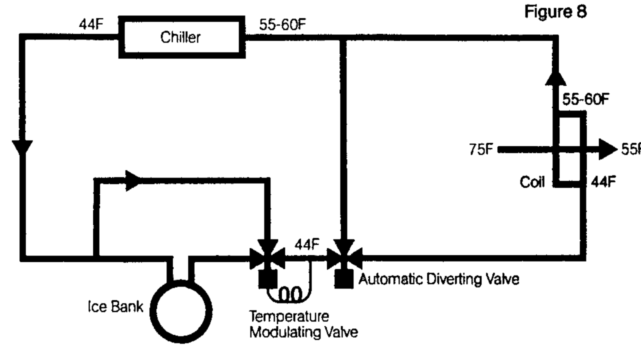


Figure 8



The glycol recommended for the solution is an ethylene glycol-based industrial coolant, such as Dow Chemical Company's Dowtherm® SR-1 or Union Carbide Corporation's UCARTHERM,® which are specially formulated for low viscosity and superior heat transfer properties. These contain a multi-component corrosion inhibitor system which is effective with most materials of construction, including aluminum, copper, solder and plastics. Unlike automotive-type anti-freeze, they produce no films and contain no anti-leak agents to interfere with heat transfer efficiency and permit use of standard system pumps, seals and air handler coils. However, because of the slight difference in heat transfer coefficient between water-glycol and plain water, coil capacity should be increased by approximately 5 percent. It is also important that the water and glycol be thoroughly mixed before the solution enters the system.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 2812EC4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ICE STORAGE COOLING SYSTEM
ANALYSIS DATE: 04-18-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	89280.
B. SIOH	$	4911.
C. DESIGN COST	$	5357.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	89593.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	89593.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 6455.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 75201.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 75201.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 0.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 6455.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 75201.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .84
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 13.88

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 2812
ENERGY CONSERVATION OPPORTUNITY: ECO-5(A)
SYSTEM MODIFICATION: TWO SPEED FANS FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO-5, install two-speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	17,273	--	59
ECO	--	8,713	--	30
Savings (Baseline-ECO)	0	8,560	0	29

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	29 MMBtu/Yr	X	$4.0141 /MMBtu	=	$117 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$117**	+	**$0**	=	**$117 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $0 per year

Total: **$0** - **$0** = **$0 per year**

[ECO-SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input (part 7). The control sequence is:

- 0-50% load, fan 1, half speed cycling.
- 50-100% load, fan 1 full speed cycling.

kWh per bin, for % design loads less than 50% load = (fan 1 power kW) * 14% * (%design load / 50) * 4 hours per bin * days per month.

kWh per bin, for % design loads 50% to 100% load = (fan 1 power kW * ((% design load)/ 100) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 2812	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	76
– WATER FLOW (gpm)	2600
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	10790
HEAT REJECTION CAPACITY (Btu/min)	215800
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	39.57
TOTAL ENTHALPY	59.57
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	162929
MOTOR DATA	
– FAN 1 POWER (kW)	11.8
– FAN 2 POWER (kW)	0

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET–BULB AVERAGES						DESIGN
	1–4	5–8	9–12	13–16	17–20	21–24	WB
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	76
MAY	57.1	56.6	61.2	63.9	63	59.4	76
JUNE	66.8	66.6	69.9	71	70.5	68.2	76
JULY	70.8	70.9	74.5	76	74.9	72.6	76
AUGUST	66.9	67	71	72	71	68.5	76
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	76
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	76

	ENTHALPY FOR AVERAGE WET–BULBS						DESIGN
	1–4	5–8	9–12	13–16	17–20	21–24	ENTHALPY
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	39.57
MAY	24.53	24.21	27.28	29.23	28.57	26.06	39.57
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	39.57
JULY	34.77	34.86	38.14	39.57	38.52	36.37	39.57
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	39.57
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	39.57
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	39.57

	COOLING PROFILE OF CENTRAL PLANTS						PEAK LOAD
	1–4	5–8	9–12	13–16	17–20	21–24	(Btuh)
APRIL	0	0	0	0	0	0	0
MAY	0.3	0.3	0.5	0.7	0.9	0.5	3740000
JUNE	0.3	0.3	0.5	0.7	0.9	0.5	4365000
JULY	0.3	0.3	0.5	0.7	0.9	0.5	4392000
AUGUST	0.3	0.3	0.5	0.7	0.9	0.5	4391000
SEPTEMBER	0.3	0.3	0.5	0.7	0.9	0.5	4329000
OCTOBER	0	0	0	0	0	0	0

	RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY						DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	2.0	2.0	1.9	1.8	1.8	1.9	30
MAY	1.8	1.8	1.6	1.5	1.6	1.7	31
JUNE	1.4	1.4	1.3	1.2	1.3	1.3	30
JULY	1.2	1.2	1.1	1.0	1.1	1.2	31
AUGUST	1.4	1.4	1.2	1.2	1.2	1.3	31
SEPTEMBER	1.5	1.5	1.4	1.3	1.4	1.5	30
OCTOBER	1.9	2.0	1.8	1.7	1.8	1.9	31

	% DESIGN LOAD						DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	14.6	14.5	26.5	39.5	49.8	25.6	31
JUNE	21.4	21.2	39.1	56.9	71.8	37.1	30
JULY	24.3	24.4	47.0	70.4	86.0	43.4	31
AUGUST	21.5	21.6	40.9	59.3	73.5	37.6	31
SEPTEMBER	20.2	20.1	36.3	52.4	64.6	34.1	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	SINGLE SPEED COOLING TOWER CYCLING (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	213	213	388	579	728	374	
JUNE	302	301	554	805	1017	525	
JULY	356	357	687	1031	1259	635	
AUGUST	315	316	598	868	1076	551	
SEPTEMBER	286	285	514	742	915	483	
OCTOBER	0	0	0	0	0	0	
TOTAL	1473	1472	2741	4025	4995	2568	17273

TWO SPEED COOLING TOWER CYCLING (kWh)							TOTAL (kWh)
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	0	0	0	0	0	0	
MAY	60	60	109	162	204	105	
JUNE	85	84	310	393	816	147	
JULY	100	100	385	803	1260	178	
AUGUST	88	88	335	478	894	154	
SEPTEMBER	80	80	144	267	611	135	
OCTOBER	0	0	0	0	0	0	
TOTAL	412	412	1282	2102	3785	719	8713

VARIABLE SPEED COOLING TOWER CYCLING (kWh)							
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	0	0	0	0	0	0	
MAY	6	6	34	113	225	31	
JUNE	17	17	106	325	656	90	
JULY	26	27	189	639	1165	149	
AUGUST	18	18	125	382	728	97	
SEPTEMBER	15	14	85	255	477	70	
OCTOBER	0	0	0	0	0	0	
TOTAL	82	82	539	1715	3251	438	6106

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.
DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C
[ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO BLDG. 2812	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
2-SPEED COOLING TOWER / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
15 HP 2-SPD MOTOR	1	EA	2.5	2.5	20	49			1795.00	1795.00	$1,844		
2-SPD MOTOR STARTER	2	EA	4.2	8.4	20	165			859.00	1718.00	$1,883		
MOTOR FEEDER	2	LS	4.1	8.1	20	160			20.00	40.00	$200		
REMOVE OLD MOTOR	2	EA	3.3	6.7	20	131					$131		
REMOVE OLD STR	2	EA	4.2	8.4	20	165					$165		
PNEUMATIC THERMOSTAT	4	EA	1.0	4.0	20	78			34.12	136.48	$215		
SUBTOTAL						$747				$3,689	$4,436		
OVERHEAD, BOND	16%					$119				$590	$710		
PROFIT	10%					$75				$369	$444		
COST SUB-TOTAL						$941				$4,649	$5,590		
CONTINGENCY	20%					$188				$930	$1,118		
SUBTOTAL						$1,129				$5,578	$6,708		
S&A	5.5%					$62				$307	$369		
TOTA[illegible]IS SHEET						$1,191				$5,885	$7,077		

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LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 2812EC5A
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	6708.
B. SIOH	$	369.
C. DESIGN COST	$	403.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	6732.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	6732.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	29.	$ 117.	11.37	1334.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		29.	$ 117.		$ 1334.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 440.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 117.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1334.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .20
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 57.40

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 2812
ENERGY CONSERVATION OPPORTUNITY: ECO-5(B)
SYSTEM MODIFICATION: VARIABLE SPEED DRIVE FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO-5, install two-speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	17,273	--	59
ECO	--	6,106	--	21
Savings (Baseline-ECO)	0	11,167	0	38

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	38 MMBtu/Yr	X	$4.0141 /MMBtu	=	$153 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$153**	+	**$0**	=	**$153 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $298 per year

Total: **$0** - **$298** = **($298) per year**

[ECO-SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input (part 7). The control sequence is:

- 0-50% load, fan 1, half speed cycling.
- 50-100% load, fan 1 full speed cycling.

kWh per bin, for % design loads less than 50% load = (fan 1 power kW) * 14% * (%design load / 50) * 4 hours per bin * days per month.

kWh per bin, for % design loads 50% to 100% load = (fan 1 power kW * ((% design load)/ 100) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 2812	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	76
– WATER FLOW (gpm)	2600
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	10790
HEAT REJECTION CAPACITY (Btu/min)	215800
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	39.57
TOTAL ENTHALPY	59.57
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	162929
MOTOR DATA	
– FAN 1 POWER (kW)	11.8
– FAN 2 POWER (kW)	0

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET-BULB AVERAGES						DESIGN WB
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	76
MAY	57.1	56.6	61.2	63.9	63	59.4	76
JUNE	66.8	66.6	69.9	71	70.5	68.2	76
JULY	70.8	70.9	74.5	76	74.9	72.6	76
AUGUST	66.9	67	71	72	71	68.5	76
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	76
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	76

	ENTHALPY FOR AVERAGE WET-BULBS						DESIGN ENTHALPY
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	39.57
MAY	24.53	24.21	27.28	29.23	28.57	26.06	39.57
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	39.57
JULY	34.77	34.86	38.14	39.57	38.52	36.37	39.57
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	39.57
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	39.57
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	39.57

COOLING PROFILE OF CENTRAL PLANTS							PEAK LOAD
	1–4	5–8	9–12	13–16	17–20	21–24	(Btuh)
APRIL	0	0	0	0	0	0	0
MAY	0.3	0.3	0.5	0.7	0.9	0.5	3740000
JUNE	0.3	0.3	0.5	0.7	0.9	0.5	4365000
JULY	0.3	0.3	0.5	0.7	0.9	0.5	4392000
AUGUST	0.3	0.3	0.5	0.7	0.9	0.5	4391000
SEPTEMBER	0.3	0.3	0.5	0.7	0.9	0.5	4329000
OCTOBER	0	0	0	0	0	0	0

RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY							DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	2.0	2.0	1.9	1.8	1.8	1.9	30
MAY	1.8	1.8	1.6	1.5	1.6	1.7	31
JUNE	1.4	1.4	1.3	1.2	1.3	1.3	30
JULY	1.2	1.2	1.1	1.0	1.1	1.2	31
AUGUST	1.4	1.4	1.2	1.2	1.2	1.3	31
SEPTEMBER	1.5	1.5	1.4	1.3	1.4	1.5	30
OCTOBER	1.9	2.0	1.8	1.7	1.8	1.9	31

% DESIGN LOAD							DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	14.6	14.5	26.5	39.5	49.8	25.6	31
JUNE	21.4	21.2	39.1	56.9	71.8	37.1	30
JULY	24.3	24.4	47.0	70.4	86.0	43.4	31
AUGUST	21.5	21.6	40.9	59.3	73.5	37.6	31
SEPTEMBER	20.2	20.1	36.3	52.4	64.6	34.1	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

SINGLE SPEED COOLING TOWER CYCLING (kWh)							TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	213	213	388	579	728	374	
JUNE	302	301	554	805	1017	525	
JULY	356	357	687	1031	1259	635	
AUGUST	315	316	598	868	1076	551	
SEPTEMBER	286	285	514	742	915	483	
OCTOBER	0	0	0	0	0	0	
TOTAL	1473	1472	2741	4025	4995	2568	17273

TWO SPEED COOLING TOWER CYCLING (kWh)							TOTAL (kWh)
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	0	0	0	0	0	0	
MAY	60	60	109	162	204	105	
JUNE	85	84	310	393	816	147	
JULY	100	100	385	803	1260	178	
AUGUST	88	88	335	478	894	154	
SEPTEMBER	80	80	144	267	611	135	
OCTOBER	0	0	0	0	0	0	
TOTAL	412	412	1282	2102	3785	719	8713

VARIABLE SPEED COOLING TOWER CYCLING (kWh)							
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	0	0	0	0	0	0	
MAY	6	6	34	113	225	31	
JUNE	17	17	106	325	656	90	
JULY	26	27	189	639	1165	149	
AUGUST	18	18	125	382	728	97	
SEPTEMBER	15	14	85	255	477	70	
OCTOBER	0	0	0	0	0	0	
TOTAL	82	82	539	1715	3251	438	6106

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C
[ ] OTHER ________

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO BLDG. 2812	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
VARIABLE SPEED COOLING TOWER / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
VFD FOR 15 HP MOTOR	1	EA	4.0	4.0	20	78			2600.00	2600.00	$2,678		
VFD WIRING & CONNECTION	1	LS	4.1	4.1	20	80			20.00	20.00	$100		
WATER TEMPERATURE SENSOR	1	EA	9.0	9.0	20	176			328.00	328.00	$504		
SUBTOTAL						$334				$2,948	$3,282		
OVERHEAD, BOND	16%					$53				$472	$525		
PROFIT	10%					$33				$295	$328		
COST SUB-TOTAL						$421				$3,714	$4,136		
CONTINGENCY	20%					$84				$743	$827		
SUBTOTAL						$505				$4,457	$4,963		
S&A	5.5%					$28				$245	$273		
TOTAL THIS SHEET						$533				$4,703	$5,236		

DA FORM [illegible], APR 85

LIFE CYCLE COST ANALYSIS SUMMARY   STUDY: 2812EC5B
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)   LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA   REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000   ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991   DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91   ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	4963.
B. SIOH	$	273.
C. DESIGN COST	$	298.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	4981.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	4981.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	38.	$ 153.	11.37	1739.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		38.	$ 153.		$ 1739.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -298.
(1) DISCOUNT FACTOR (TABLE A)   11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -3472.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -3472.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 574.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -145.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -1732.

6. DISCOUNTED SAVINGS RATIO   (SIR)=(5 / 1F)= -.35
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED)   SPB=1F/4   -34.34

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 2812
ENERGY CONSERVATION OPPORTUNITY: ECO- 6
SYSTEM MODIFICATION: HIGH EFFICIENCY MOTOR REPLACEMENT
SYSTEMS TO MODIFY: PUMP & COOLING TOWER MOTORS

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO–6, install high efficiency motors.
It was estimated that the electrical energy can be saved by installing high efficiency motors based on the motor operating hours per year.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline–ECO)	4	18,353	0	63

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	63 MMBtu/Yr	X	$4.0141 /MMBtu	=	$251 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$251**	+	**$0**	=	**$251 per year**

NON–ENERGY SAVINGS (+), COST (–):

Demand: 4 kW/month X $1.787 /kW X 12 months/year

= (+) $86 per year

Maintenance: = (–) $0 per year

Total: **$86** – **$0** = **$86 per year**

[ECO–SHT.WK3]

HIGH EFFICIENCY MOTOR REPLACEMENT

LABOR RATE:	19.6	$/hr
ELECTRIC CONS.	0.0137	$/kWH
ELECTRIC DEMAND	1.787	$/kW

BLDG. NO.	EQUIPMENT SERVE	MOTOR HP	MOTOR FLA	MEAS AMPS	MEAS PF	MEAS VOLT	EXST EFF	NEW EFF	KW SVGS	HRS/ YEAR	KWH/YR SVGS	SVGS/ YEAR
730	CWP-1	150.0	179.0	147.0	0.87	460	90.19%	95.00%	5.73	2641	15120	$330
	CWP-2	150.0	179.0	148.0	0.91	460	86.22%	95.00%	11.50	1873	21539	$542
	CNWP-1	50.0	118.0	107.0	0.98	230	80.97%	93.00%	6.67	2641	17629	$385
	CNWP-2	50.0	118.0	107.0	0.99	230	80.15%	93.00%	7.27	468	3405	$203
	CNWP-3	NI	NI	NI								
	CTM-1	30.0	71.4	70.7	0.93	230	84.60%	92.40%	2.61	702	1834	$81
	CTM-2	30.0	71.4	71.0	0.87	230	90.44%	92.40%	0.58	702	405	$18
	HWP-1	50.0	125.0	117.5	0.87	230	86.10%	93.00%	3.51	3624	12722	$250
	HWP-2	50.0	125.0	118.0	0.87	230	86.10%	93.00%	3.53	3624	12776	$251
		DEMAND CREDIT		**$888**	**MMBtu**	**292**		**TOTAL**	**41**		**85430**	**$2,058**
914	CWP-1	40.0	48.0	41.3	0.87	460	89.69%	93.00%	1.14	3672	4178	$82
	CNWP-1	15.0	19.0	14.4	0.82	460	90.15%	90.20%	0.01	3672	23	$0
	CTM-1	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	CTM-2	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	HWP-1	2.0	6.2	5.4	0.87	230	69.43%	84.00%	0.47	3624	1694	$33
	HWP-2	2.0	6.2	5.6	0.87	230	69.43%	84.00%	0.48	3624	1757	$34
		DEMAND CREDIT		**$111**	**MMBtu**	**30**		**TOTAL**	**5**		**8932**	**$233**
2812	CWP-1	20.0	27.0	23.0	0.77	460	90.07%	91.00%	0.16	3672	586	$11
	CNWP-1	25.0	31.5	26.5	0.82	460	91.18%	91.70%	0.11	3672	394	$8
	CTM-1	15.0	18.6	18.6	0.87	460	86.79%	90.20%	0.56	1167	655	$21
	HWP-1	7.5	21.6	18.5	0.87	230	74.74%	88.50%	1.33	8760	11687	$189
	HWP-2	7.5	21.6	19.0	0.87	230	74.74%	88.50%	1.37	3672	5031	$98
		DEMAND CREDIT		**$76**	**MMBtu**	**63**		**TOTAL**	**4**		**18353**	**$327**
3442	CWP-1	60.0	73.0	63.0	0.84	460	91.62%	94.50%	1.40	3672	5158	$101
	CWP-2	60.0	73.0	63.4	0.84	460	91.62%	94.50%	1.41	3672	5191	$101
	CNWP-1	40.0	52.0	41.0	0.78	460	92.34%	93.00%	0.20	3672	721	$14
	CNWP-2	40.0	52.0	35.8	0.78	460	92.34%	93.00%	0.17	3672	629	$12
	CTM-1	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-2	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-3	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-4	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
		DEMAND CREDIT		**$90**	**MMBtu**	**44**		**TOTAL**	**4**		**12880**	**$266**
4701	CWP-1	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CWP-2	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CNWP-1	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CNWP-2	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CTM-1	20.0	24.6	18.2	0.87	460	87.50%	91.00%	0.55	650	361	$17
	CTM-2	15.0	19.2	16.5	0.87	440	87.90%	90.20%	0.32	650	206	$10
		DEMAND CREDIT		**$65**	**MMBtu**	**16**		**TOTAL**	**3**		**4605**	**$128**
5676	HCP-1	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	HCP-2	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	10.5	9	0.79	460	84.66%	88.50%	0.29	1160	337	$11
		DEMAND CREDIT		**$94**	**MMBtu**	**83**		**TOTAL**	**4**		**24287**	**$427**
5678	HCP-1	2.0	6.5	5.9	0.83	208	76.76%	84.00%	0.20	7296	1445	$24
	HCP-2	2.0	6.5	5.7	0.83	208	76.76%	84.00%	0.19	7296	1396	$23
	HCP-3	1.5	4.8	4.5	0.83	230	70.51%	84.00%	0.34	7296	2474	$41
	HCP-4	2.0	6.3	5.8	0.83	230	71.62%	84.00%	0.39	7296	2878	$48
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	11	9.6	0.75	460	85.12%	88.50%	0.26	1139	293	$10
		DEMAND CREDIT		**$64**	**MMBtu**	**49**		**TOTAL**	**3**		**14412**	**$262**

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59–90–C–0087	EFFECTIVE PRICING DATE APR. 91	DATE PREPARED 10–Apr–91
PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER	CODE A [X] CODE B [ ] CODE C	DRAWING NO.	SHT OF
LOCATION FT. SILL, OKLAHOMA	[ ] OTHER ________	ESTIMATOR KC	CHECKED BY CEL

MOTOR REP. ECO BLDG. 2812	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
HIGH EFF. MOTOR REP.LACEMENT TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CWP–1 20.0 HP MOTOR	1	EA	5.5	5.5	20	109			1189.0	1189.00	$1,298		
CNWP–1 25.0 HP MOTOR	1	EA	5.8	5.8	20	113			1396.0	1396.00	$1,509		
CTM–1 15.0 HP MOTOR	1	EA	4.5	4.5	20	88			985.0	985.00	$1,073		
HWP–1 7.5 HP MOTOR	1	EA	3.4	3.4	20	67			616.0	616.00	$683		
HWP–2 7.5 HP MOTOR	1	EA	3.4	3.4	20	67			616.0	616.00	$683		
SUBTOTAL						$444				$4,802	$5,246		
OVERHEAD, BOND	16%					$71				$768	$839		
PROFIT	10%					$44				$480	$525		
'COST SUB–TOTAL						$559				$6,051	$6,610		
CONTINGENCY	20%					$112				$1,210	$1,322		
SUBTOTAL						$671				$7,261	$7,932		
S&A	5.5%					$37				$399	$436		
TOTAL[illegible]S SHEET						$708				$7,660	$8,368		

DA FORM [illegible], APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 2812EC6
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
.LATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
.ECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
.SCAL YEAR 1991 DISCRETE PORTION NAME: HIGH EFF. MOTOR
ANALYSIS DATE: 04-15-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	7932.
B. SIOH	$	437.
C. DESIGN COST	$	476.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	7961.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	7961.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	63.	$ 251.	11.37	2857.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		63.	$ 251.		$ 2857.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 86.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 1002.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 1002.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 943.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .48
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 337.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 3859.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .48
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 23.60

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 2812
ENERGY CONSERVATION OPPORTUNITY: ECO-7
SYSTEM MODIFICATION: INSTALL INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-7, install instrumentation to facilitate efficient operation of boiler plant. It was estimated that the energy wasted from boiler in standby is 1% of the rated output capacity. The hours when boilers are running unnecessary were estimated for each boiler.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	0	0	21	21

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	21 MMBtu/Yr	X	$2.92 /MMBtu	=	$61 per year
Total Energy Cost Savings:	**$0**	+	**$61**	=	**$61 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $320 per year

Total: **$0** - **$320** = **($320) per year**

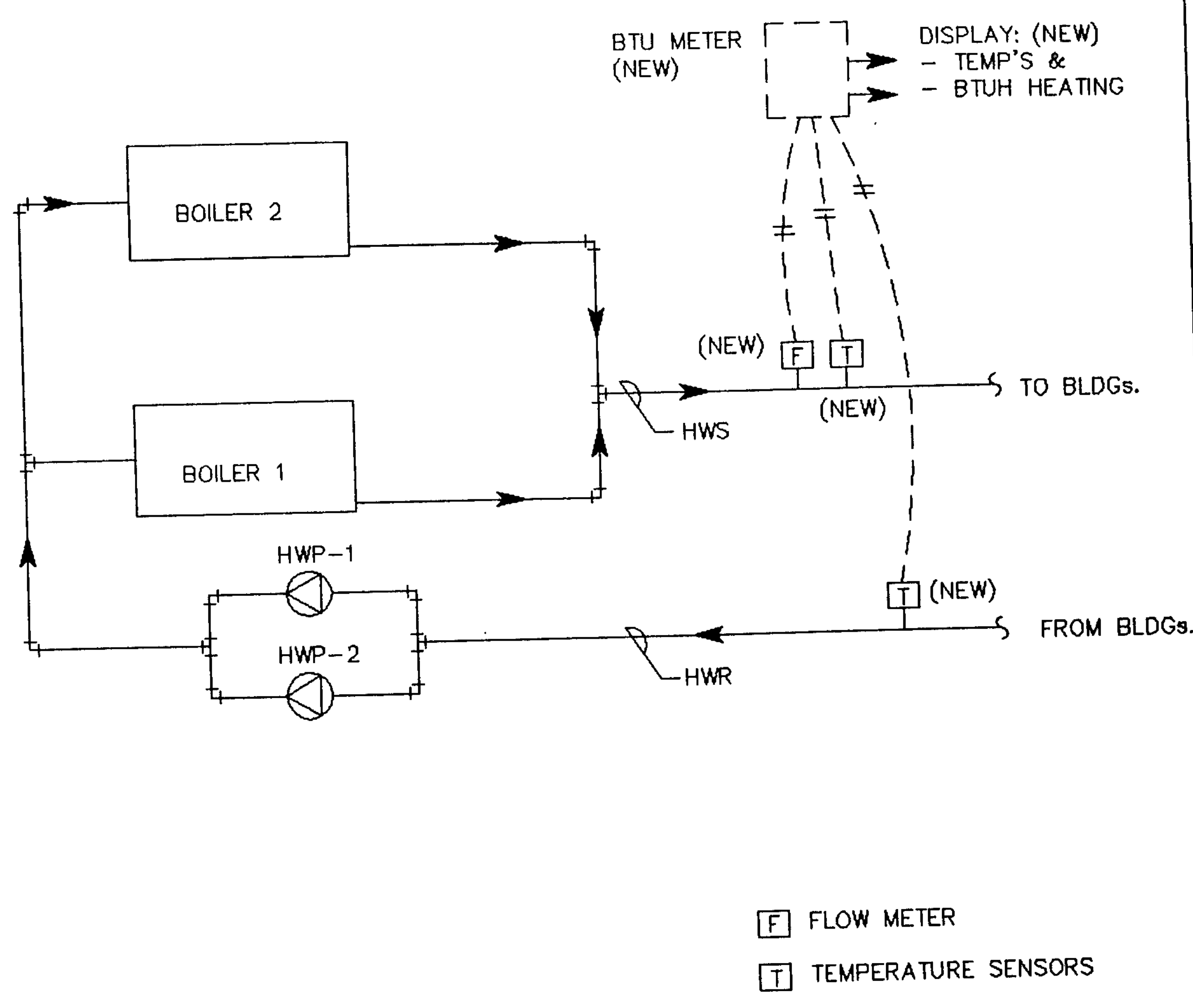
[ECO-SHT.WK3]

BOILER STANDBY SAVINGS

CENTRAL PLANT	BOILER NO.	BOILER TYPE	BOILER MANUFACTURERER	BOILER MODEL NUMBER	RATED BOILER OUTPUT MMBTU/H	CALC. BOILER OUTPUT MMBTU/H	STANDBY LOSS (1%) MMBTU/H	EXCESS STANDBY (HRS/YR)	EXCESS STANDBY MMBTU/H	EXCESS STANDBY SAVINGS ($)
5900	1	HTHW	INTERNATIONAL	D-12	10.00	6.94	0.0694	0		
	2	HTHW	INTERNATIONAL	D-12	10.00	7.17	0.0717	720	51.62	$150.74
	3	HTHW	HERCULES	300	9.70	7.61	0.0761	720	54.82	$160.09
	4	HTHW	HERCULES	300	9.70	7.58	0.0758	720	54.55	$159.27
	5	HTHW	INTERNATIONAL	1035 TH12	8.00	6.22	0.0622	0		
	6	HTHW	INTERNATIONAL	TJW-C-10	11.20	8.88	0.0888	0		
						TOTAL		2160	160.99	$470.10
6003	1	STEAM-12	KEWANEE	L39-350-605	11.72	9.41	0.0941	0		
	2	STEAM-12	YORK SHIPLEY	SPL-350-112080	11.72	9.12	0.0912	0		
	3	STEAM-12	KEWANEE	L36-350-605	11.72	9.37	0.0937	720	67.45	$196.96
						TOTAL		720	67.45	$196.96
730	1	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	0		
	2	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	720	44.34	$129.47
	3	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.18	0.0618	720	44.51	$129.96
	4	STEAM-12	KEWANEE	CAT#7L280-KG-06	2.66	2.11	0.0211	0		
						TOTAL		1440	88.84	$259.43
2812	1	STEAM-12	FEDERAL BOILER CO	GS 3562	1.80	1.40	0.0140	0		
	2	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.77	0.0277	0		
	3	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.86	0.0286	720	20.62	$60.21
						TOTAL		720	20.62	$60.21
5676	1	HW	AMERICAN STANDARD	PF 515	2.44	1.80	0.0180	720	12.93	$37.76
	2	HW	AMERICAN STANDARD	PF 515	2.44	1.71	0.0171	0		
						TOTAL		720	12.93	$37.76
5678	1	HW	BRUNHAM	PF 514	2.27	1.50	0.0150	720	10.79	$31.50
	2	HW	BRUNHAM	PF 514	2.27	1.63	0.0163	0		
						TOTAL		720	10.79	$31.50
914	1	STEAM-12	BRUNHAM	PF-510	1.61	1.29	0.0129	0		
	2	HW	RAY-PAK	EA 200ITB	1.61	1.22	0.0122	0		
	3	HW	AMERICAN STANDARD	G1015	1.92	1.47	0.0147	720	10.56	$30.84
	4	HW	AMERICAN STANDARD	G1015	1.92	1.40	0.0140	0		
						TOTAL		720	10.56	$30.84
4701	1	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	0		
	2	STEAM-100	BIRCHFIELD	FBH 578	11.00	0.00	0.0000	0		
	3	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	720	60.73	$177.33
						TOTAL		720	60.73	$177.33

[BOILERS.WK3]

ECO-7, INSTRUMENTATION FOR BOILER PLANT
(TYPICAL)



[B-ECO-7.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C

[ ] OTHER ________

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

BOILER ECO BLDG. 2812	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
INSTRUMENTATION / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 2 HW BOILERS													
HWS TEMPERATURE SENSOR	1	EA			176	176			328.00	328.00	$504		
HWR TEMPERATURE SENSOR	1	EA			176	176			328.00	328.00	$504		
INSERT. FLOW METER	1	EA			197	197			764.00	764.00	$961		
BTU METER	1	EA	6.0	6.0	20	118			820.00	820.00	$938		
LED DISPLAY	2	EA							60.00	120.00	$120		
LED INSTALLATION	2	EA	4.6	9.2	19.6	180			158	316	496.32		
SUBTOTAL						$847				$2,676	$3,523		
OVERHEAD, BOND	16%					$136				$428	$564		
PROFIT	10%					$85				$268	$352		
COST SUB-TOTAL						$1,067				$3,372	$4,439		
CONTINGENCY	20%					$213				$674	$888		
SUBTOTAL						$1,281				$4,046	$5,327		
S&A	5.5%					$70				$223	$293		
TOTAL THIS SHEET						$1,351				$4,269	$5,620		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: B2812E12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER INSTRUMENTATION
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	5327.
B. SIOH	$	293.
C. DESIGN COST	$	320.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	5346.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	5346.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	21.	$ 60.	12.48	751.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		21.	$ 60.		$ 751.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -320.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -2915.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -2915.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 248.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -260.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -2164.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.40
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -20.58

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 2812
ENERGY CONSERVATION OPPORTUNITY: ECO-8
SYSTEM MODIFICATION: BOILER OPTIMIZATION, CONTROL & INSTRUMENTATION
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-8, install instrumentation connected to EMCS for boiler optimization.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	27,451	27,451
ECO	--	--	27,144	27,144
Savings (Baseline-ECO)	0	0	307	307

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	307 MMBtu/Yr	X	$2.92 /MMBtu	=	$896 per year
Total Energy Cost Savings:	**$0**	**+**	**$896**	**=**	**$896 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $1,543 per year

Total: **$0** **-** **$1,543** **=** **($1,543) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

** TOTAL **

SYSTEM C1 HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	27450.
PEAK DAY GAS CONSUMP., 1000 CU FT	237.
ELECTRICAL CONSUMPTION, KWH	479788.
PEAK KW DEMAND (15 MIN BASIS)	192.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	479788.
ON-PEAK KW DEMAND (15 MIN BASIS)	192.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3027
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

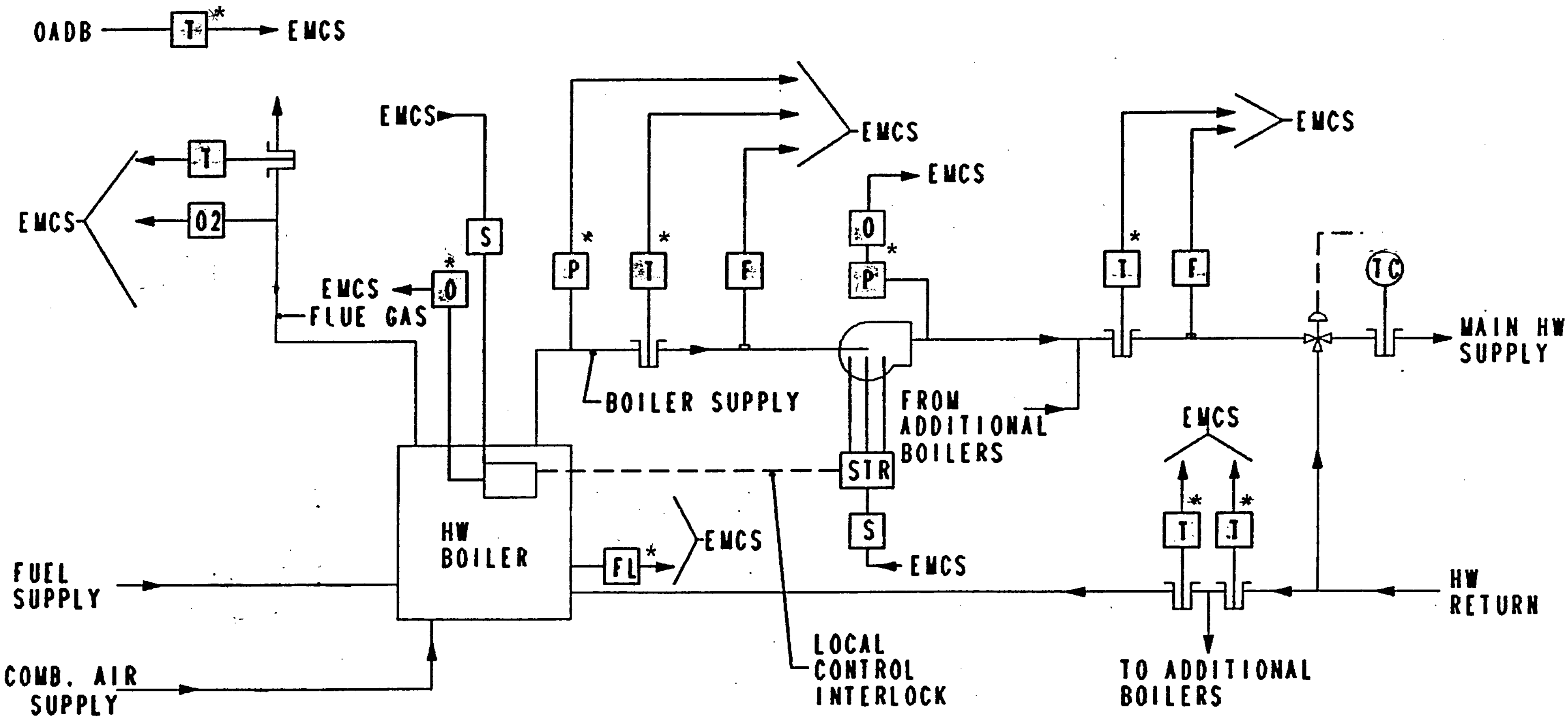
PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER ECO-2

** TOTAL **

SYSTEM C1 HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS

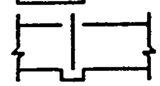
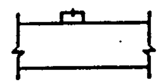
FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	27143.
PEAK DAY GAS CONSUMP., 1000 CU FT	237.
ELECTRICAL CONSUMPTION, KWH	469753.
PEAK KW DEMAND (15 MIN BASIS)	192.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	469753.
ON-PEAK KW DEMAND (15 MIN BASIS)	192.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2955
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.



Hot water boiler

* - Points included on proposed EMCS design, existing.
All other points are new.

→ EMCS	SIGNAL TRANSMITTED TO EMCS
← EMCS	SIGNAL TRANSMITTED FROM EMCS
A	ALARM CONTACT SIGNAL
E	ECONOMIZER CONTROL INTERFACE
F	FLOW INDICATION
FL	FLAME INDICATION
H	HUMIDITY INDICATION
P	PRESSURE INDICATION
LV	LEVEL INDICATION
M	METER
O	ON-OFF STATUS SIGNAL
DP	DIFFERENTIAL PRESSURE SWITCH
R	CONTROLLER RESET INTERFACE
S	START-STOP INTERFACE
T	TEMPERATURE INDICATION
V	VENTILATION/RECIRCULATION CONTROL
PS	POSITION
O_2	FLUE GAS ANALYSIS, OXYGEN
Co	FLUE GAS ANALYSIS, CARBON MONOXIDE

FD	FURNACE DRAFT DIFFERENTIAL PRESSURE
DS	HIGH-LOW DEMAND SIGNAL SELECTOR
TC	TEMPERATURE CONTROLLER
PC	PRESSURE CONTROLLER
STR	MOTOR STARTER
	SENSOR INSTALLED IN THERMOMETER WELL
	SENSOR INSTALLED IN DUCT OR PLENUM
CHW	CHILLED WATER
EA	EXHAUST AIR
SA	SUPPLY AIR
RA	RETURN AIR
OA	OUTSIDE AIR
MA	MIXED AIR
WB	WET BULB
DB	DRY BULB
OAD	OUTSIDE AIR DAMPER
RAD	RETURN AIR DAMPER
EAD	EXHAUST AIR DAMPER
MZD	MULTIZONE DAMPER
RH	RELATIVE HUMIDITY

Symbols and Abbreviations

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 12-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

[ ] CODE A [X] CODE B [ ] CODE C
[ ] OTHER

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO BLDG. 2812	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
OPTIMIZE BOILER SEQUENCE / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 2 HW BOILERS													
HWS TEMPERATURE SENSOR *	2	EA			176	$352			$328	$656	$1,664		
HWR TEMPERATURE SENSOR *	2	EA			176	$352			$328	$656	$1,664		
HWP ST/SP	2	LS			39	$78			$226	$452	$530		
DP (LIQUID) PUMP STATUS *	2	LS			155	$310			$205	$410	$1,130		
BOILER ST/SP	2	EA	2.0	4.0	20	$78			$226	$452	$530		
FID PANEL & ACCESSORIES *	1	LS			208	$208			$3,681	$3,681	$7,570		
FID SOFTWARE COMMISSIONING	1	EA	6.0	6.0	45	$270					$270		
FID TESTING	1	EA	6.0	6.0	45	$270					$270		
INST. FLOW METER	1	EA	3.5	3.5	20	$69			500	$500	$569		
STACK O2 SENSOR	2	LS			338	$676			$3,483	$6,966	$7,642		
STACK TEMP. SENSOR	2	EA	4.0	8.0	20	$157			$207	$413	$570		
CREDIT FROM EMCS PROJECT *						($1,222)				($5,403)	($6,625)		
SUBTOTAL						$2,820				$14,186	$17,006		
OVERHEAD, BOND	16.0%					$451				$2,270	$2,721		
PROFIT	10.0%					$282				$1,419	$1,701		
COST SUB-TOTAL						$3,553				$17,874	$21,428		
CONTINGENCY	20.0%					$711				$3,575	$4,286		
SUBTOTAL						$4,264				$21,449	$25,713		
S&A	5.5%					$235				$1,180	$1,414		
TOTAL [illegible] SHEET						$4,499				$22,629	$27,128		

DA FORM 5[illegible], APR 85

LIFE CYCLE COST ANALYSIS SUMMARY   STUDY: B2812E12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)   LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA   REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000   ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991   DISCRETE PORTION NAME: BOILER OPTIMIZATION
ANALYSIS DATE: 04-12-91   ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	25713.
B. SIOH	$	1415.
C. DESIGN COST	$	1543.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	25804.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	25804.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	307.	$ 896.	12.48	11188.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		307.	$ 896.		$ 11188.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1543.
(1) DISCOUNT FACTOR (TABLE A)   9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -14057.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -14057.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3692.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -647.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -2869.

6. DISCOUNTED SAVINGS RATIO   (SIR)=(5 / 1F)= -.11
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4   -39.91

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 2812
ENERGY CONSERVATION OPPORTUNITY: ECO-9
SYSTEM MODIFICATION: RENOVATE BOILERS
SYSTEMS TO MODIFY: BOILERS 1, 2, AND 3

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-9, renovate or replace existing boilers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	27,451	27,451
ECO	--	--	26,830	26,830
Savings (Baseline-ECO)	0	0	621	621

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	621 MMBtu/Yr	X	$2.92 /MMBtu	=	$1,813 per year
Total Energy Cost Savings:	**$0**	+	**$1,813**	=	**$1,813 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $1,056 per year

Total: **$0** - **$1,056** = **($1,056) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

** TOTAL **

SYSTEM C1 HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	27450.
PEAK DAY GAS CONSUMP., 1000 CU FT	237.
ELECTRICAL CONSUMPTION, KWH	479788.
PEAK KW DEMAND (15 MIN BASIS)	192.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	479788.
ON-PEAK KW DEMAND (15 MIN BASIS)	192.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3027
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER ECO-3

** TOTAL **

SYSTEM C1 HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	26830.
PEAK DAY GAS CONSUMP., 1000 CU FT	237.
ELECTRICAL CONSUMPTION, KWH	479788.
PEAK KW DEMAND (15 MIN BASIS)	192.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	479788.
ON-PEAK KW DEMAND (15 MIN BASIS)	192.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3027
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

☐ CODE A ☒ CODE B ☐ CODE C
☐ OTHER

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 12-Apr-91

DRAWING NO.

SHT OF

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO BLDG. 2812	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
BOILER RENOVATION / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
RENOVATION OF BOILER 3													
CLEAN TUBES	1	EA	16.0	16.0	24	$384					$384		
REBUILD REFACTORY	1	EA	40.0	40.0	24	$960					$960		
NEW INSULATION	1	LS							$1,920	$1,920	$1,920		
ADJUST CONTROLS	1	EA	6.7	6.7	24	$160					$160		
ACIDIZING	1	EA	6.7	6.7	24	$160					$160		
CLEAN ADJUST BURNERS	1	EA	4.0	4.0	24	$96					$96		
TEST BOILERS	1	EA	4.0	4.0	24	$96					$96		
NEW INSTRUMENTS	1	LS							$200	$200	$200		
ANNUAL RECURRING COST													
CLEAN TUBES	1	EA	16.0	16.0	24	$384					$384		
ADJUST CONTROLS	1	EA	6.7	6.7	24	$160					$160		
ACIDIZING	2	EA	6.7	13.3	24	$320					$320		
CLEAN ADJUST BURNERS	1	EA	4.0	4.0	24	$96					$96		
TEST BOILERS	1	EA	4.0	4.0	24	$96					$96		
TOTAL											$1,056		
SUBTOTAL						$1,856				$2,120	$3,976		
OVERHEAD, BOND	16.0%					$297				$339	$636		
PROFIT	10.0%					$186				$212	$398		
COST SUB-TOTAL						$2,339				$2,671	$5,010		
CONTINGENCY	20.0%					$468				$534	$1,002		
SUBTOTAL						$2,806				$3,205	$6,012		
S&A	5.5%					$154				$176	$331		
TOTAL THIS SHEET (WO/ANNUAL RECC. COST)						$2,961				$3,382	$6,342		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: B2812EC3

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.035

INSTALLATION & LOCATION: FT. SILL, OKLAHOMA   REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000   ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991   DISCRETE PORTION NAME: BOILER RENOVATION
ANALYSIS DATE: 04-09-91   ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	6012.
B. SIOH	$	331.
C. DESIGN COST	$	361.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	6034.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	6034.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	621.	$ 1813.	12.48	22630.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		621.	$ 1813.		$ 22630.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) — $ -1056.
   (1) DISCOUNT FACTOR (TABLE A) — 9.11
   (2) DISCOUNTED SAVING/COST (3A X 3A1) — $ -9620.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -9620.

D. PROJECT NON ENERGY QUALIFICATION TEST
   (1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 7468.
      A IF 3D1 IS = OR > 3C GO TO ITEM 4
      B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
      C IF 3D1B IS = > 1 GO TO ITEM 4
      D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 757.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 13010.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 2.16
   (IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 7.97

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 2812
ENERGY CONSERVATION OPPORTUNITY: ECO-16
SYSTEM MODIFICATION: ENGINE DRIVEN CHILLER
SYSTEMS TO MODIFY: CHILLER 1

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-16, install nat. gas engine driven chiller.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	192	426,000	5,252	6,706
ECO	48	148,000	6,702	7,207
Savings (Baseline-ECO)	144	278,000	(1,450)	(501)

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	949 MMBtu/Yr	X	$4.0141 /MMBtu	=	$3,809 per year
Nat. Gas:	-1450 MMBtu/Yr	X	$2.92 /MMBtu	=	($4,234)per year
Total Energy Cost Savings:	**$3,809**	**+**	**($4,234)**	**=**	**($425) per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 144 kW/month X $1.787 /kW X 12 months/year
= (+) $3,088 per year

Maintenance: = (-) $384 per year

Total: $3,088 - $384 = $2,704 per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

		GAS DEMAND MCF	GAS CONSUMP MCF	****************** PURCHASED ON-PK DEMAND KW	ON-PK CONSUMP THOU KWH	MID-PK DEMAND KW	ELECTRICAL MID-PK CONSUMP THOU KWH	OFF-PK DEMAND KW	***************** OFF-PK CONSUMP THOU KWH	AUX FUEL CONSUMP	AUX FUEL HRS
C1	1	237.	7351.	15.	11.	0.	0.	0.	0.	0.	0.
C1	2	237.	6124.	15.	10.	0.	0.	0.	0.	0.	0.
C1	3	165.	4512.	15.	11.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	108.	65.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	171.	87.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	189.	97.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	192.	98.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	148.	79.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	131.	3330.	15.	11.	0.	0.	0.	0.	0.	0.
C1	12	223.	6134.	15.	11.	0.	0.	0.	0.	0.	0.

Electrical Consumption May through September, 426,000 kWh
Electrical Demand Peak, August, 192 kW

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 ECO-15

				****************** PURCHASED	ELECTRICAL *****************						
		GAS DEMAND MCF	GAS CONSUMP MCF	ON-PK DEMAND KW	ON-PK CONSUMP THOU KWH	MID-PK DEMAND KW	MID-PK CONSUMP THOU KWH	OFF-PK DEMAND KW	OFF-PK CONSUMP THOU KWH	AUX FUEL CONSUMP	AUX FUEL HRS
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	43.	1053.	8.	5.	0.	0.	0.	0.	0.	0.
C1	5	49.	1444.	43.	30.	0.	0.	0.	0.	0.	0.
C1	6	47.	1295.	47.	29.	0.	0.	0.	0.	0.	0.
C1	7	46.	1304.	48.	30.	0.	0.	0.	0.	0.	0.
C1	8	46.	1303.	48.	30.	0.	0.	0.	0.	0.	0.
C1	9	49.	1356.	45.	29.	0.	0.	0.	0.	0.	0.
C1	10	43.	1089.	8.	6.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Gas Consumption May through September, 6702 MMBtu
Electrical Consumption May through September, 148,000 kWh
Electrical Demand Peak, August, 48 kW

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-2

				****************** PURCHASED	ELECTRICAL	*****************					
		GAS DEMAND MCF	GAS CONSUMP MCF	ON-PK DEMAND KW	ON-PK CONSUMP THOU KWH	MID-PK DEMAND KW	MID-PK CONSUMP THOU KWH	OFF-PK DEMAND KW	OFF-PK CONSUMP THOU KWH	AUX FUEL CONSUMP	AUX FUEL HRS
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	39.	1030.	8.	5.	0.	0.	0.	0.	0.	0.
C1	5	39.	1064.	8.	6.	0.	0.	0.	0.	0.	0.
C1	6	40.	1030.	8.	5.	0.	0.	0.	0.	0.	0.
C1	7	39.	1064.	8.	6.	0.	0.	0.	0.	0.	0.
C1	8	39.	1064.	8.	6.	0.	0.	0.	0.	0.	0.
C1	9	39.	1030.	8.	5.	0.	0.	0.	0.	0.	0.
C1	10	39.	1064.	8.	6.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Gas Consumption May through September, 5252 MMBtu

TECOCHILL™

Gas Engine Driven Chiller Systems

Centrifugal Compressor Line

- **30 to 95% Energy Savings**
- **Fully Automatic Unattended Operation**
- **Continuous 20 to 100% Modulation**
- **Open Drive Compressor**
- **Hot Water Available**
- **Remote Diagnostics**
- **Made in U.S.A.**

TECOCHILL centrifugal chillers provide cost effective and reliable chilled water for commercial, industrial and institutional cooling needs. The chillers combine the familiarity of vapor compression refrigeration with the energy efficiency of TecoDrive, a natural gas prime mover. TECOCHILL chillers provide substantial savings over electric and absorption chillers by reducing energy costs 30 to 95%. These savings are due to an exceptionally efficient design, lower utility costs and avoided electric demand charges.

The TECOCHILL CH-500 chiller uses two TecoDrive engines directly coupled to open-drive centrifugal compressors. The TECOCHILL CH-250 chiller uses a single TecoDrive engine. TecoDrive engines have earned a strong reputation for reliability and performance in the HVAC community. This reputation has resulted from millions of hours of operation in chillers and cogeneration modules.

TECOCHILL chillers provide the highest coefficient of performance (COP) of any type of gas chiller. The inherent variable speed capability of the TecoDrive engine and compressor team offers even higher part-load system efficiencies and superior load following capability. Continuous modulation from 20 to 100% provides customers with precisely controlled chilled water temperature.

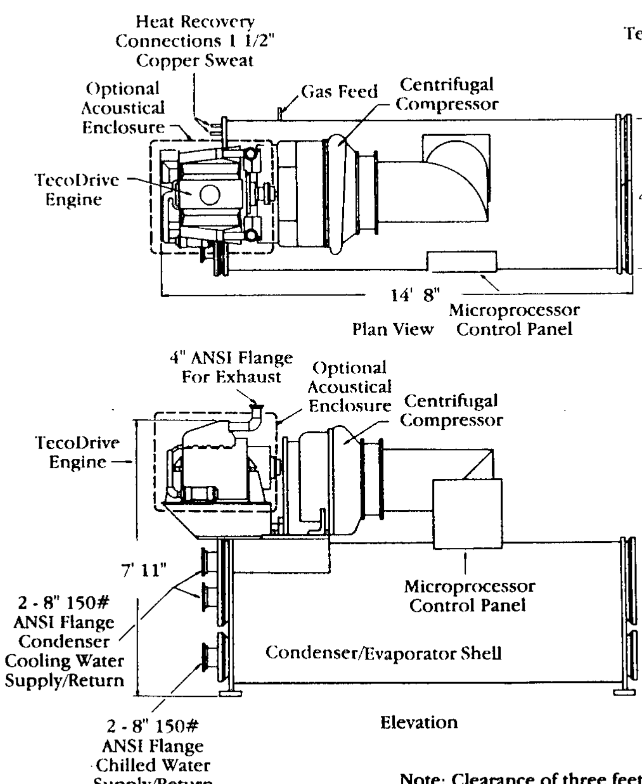
A powerful microprocessor based control system provides fully automatic operation, continuous chiller monitoring, digital display, fault and safety diagnostics and convenient interface to energy management systems in a user-friendly package. These features have resulted in a significant reduction in service costs.

Optional equipment includes a heat recovery package that yields as much as 1,700,000 Btu/hr of hot water which can supplement boilers or other thermal needs. Acoustical enclosures are available that reduce noise level. A remote monitoring and control system is available that permits remote operation and diagnostics via telephone and personal computer.

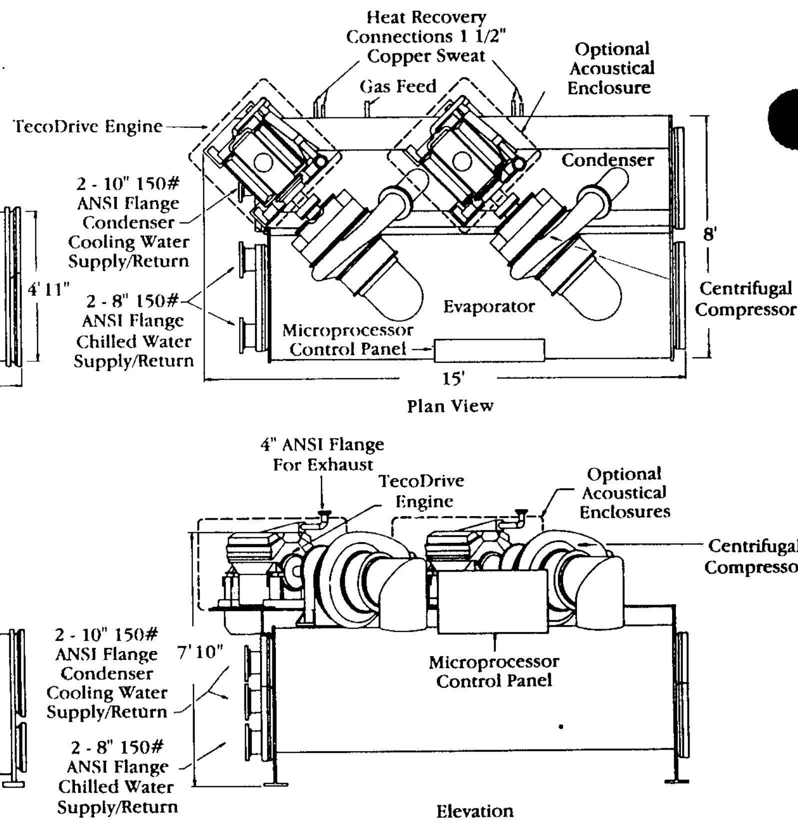
Made in the USA, TECOCHILL chillers are readily available and serviced by factory-trained local HVAC service professionals. TECOCHILL chillers are equal in size to electric chillers and smaller than absorption chillers. Also, open-drive compressors allow easier conversion to alternate refrigerants in the future. The chiller has been designed for ease of installation and with standard connections.

A cooling system evaluation is no longer complete without a TECOCHILL comparison. For further information, please contact Tecogen Inc. directly or our local sales representative.

TECOCHILL CH-250



TECOCHILL CH-500



Note: Clearance of three feet required on all sides. Scale: 3/16" = 1 ft.
All specifications and materials subject to change without notice.
All specifications and ratings are +5%

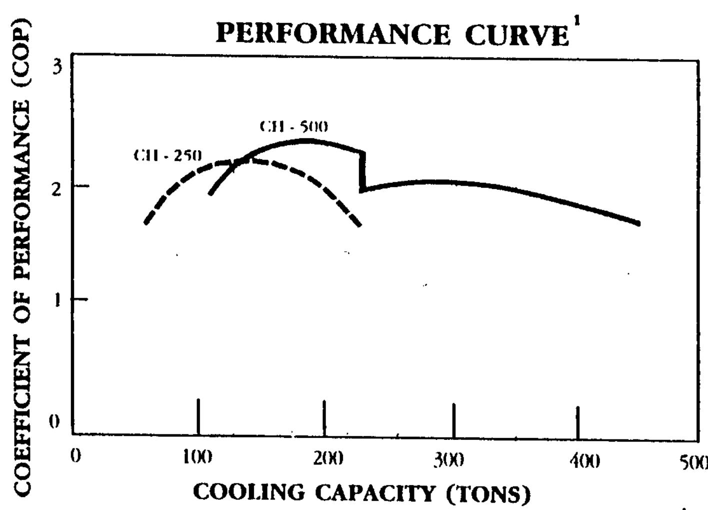
[redacted]

GENERAL SPECIFICATIONS

Model	CH - 250	CH - 500
Capacity (Tons)[1]	~~230~~ 220	~~460~~ 430
COP		
Full load	1.7	1.7
Integrated Part Load Value (IPLV)	2.0	2.0
RPM Full Load	3000	3000
Gas Input (SCFH)[2] @6 - 28 in. H_2O	1750	3500
Recoverable Heat at Full Load (BTU/H)[3]	850,000	1,700,000
Acoustic Level (dBA) @ 20 ft.with Optional Enclosure	82	85
Electric Power Requirements	208 VAC Three phase, 35 Amps Service, 4 kW	208 VAC Three phase, 50 Amps Service, 7 kW
Chilled Water Flow(GPM)	600	1200
Cooling Tower Requirements		
Condenser Flow Rate (GPM)	750	1500
Pressure Drop (ft. H_2O)	11	11
Temperatures, without Exhaust Heat Exchangers (°F)[3]	85.0 - 95.0	85.0 - 95.0
Temperatures, with Exhaust Heat Exchangers (°F)[3]	85.0 - 96.3	85.0 - 96.3
Exhaust		
Without Exhaust Heat Exchangers[3]	4 in. ANSI Flange, 300 SCFM, 26 in. of water max. back pressure, 1200°F max. temperature	(Same per engine)
With Exhaust Heat Exchangers[3]	4 in. ANSI Flange, 300 SCFM, 16 in. of water max. back pressure, 300°F max. temperature	(Same per engine)
Refrigerant	R-11(1,010 lbs.)	R-11 (1,770lbs)
TecoDrive™ Engines	One	Two
Rigging Weight (lbs.)	18,000	26,000
Dimensions	14'8"long x 4'11" wide x 7'11" high	15' long x 8' wide x 7'10" high

Note 1. Per ARI 550 - 88 Method
Note 2. HHV 1020 BTU/SCF
Note 3. 60% of heat from engine jacket, exhaust manifold and oil cooler; 40% from engine exhaust heat exchanger

PERFORMANCE CURVE[1]



All specifications and materials subject to change without notice.
All specifications and ratings are +5%

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 15-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

[ ] CODE A [X] CODE B [ ] CODE C

[ ] OTHER ______

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO BLDG. 2812	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
NAT. GAS ENGINE DRIVEN CHILLER TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
ENGINE DRIVEN CHILLER	1	EA	56.0	56.0	24	1344			275000.00	275000.00	$276,894		
MISC. PIPE CONNECTION	1	LS							1500.00	1500.00	$1,500		
REMOVE EXISTING CHILLER	1	EA	36.0	36.0	24	864					$864		
SUBTOTAL						$2,208				$276,500	$278,708		
OVERHEAD, BOND	16%					$353				$44,240	$44,593		
PROFIT	10%					$221				$27,650	$27,871		
COST SUB-TOTAL						$2,782				$348,390	$351,172		
CONTINGENCY	20%					$556				$69,678	$70,234		
SUBTOTAL						$3,338				$418,068	$421,406		
S&A	5.5%					$184				$22,994	$23,177		
TOTAL THIS SHEET						$3,522				$441,062	$444,584		

DA FORM [illegible], APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 2812EC15
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: NAT. GAS ENGINE DRIVEN CHILLER REPLACEME
ANALYSIS DATE: 04-15-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	421406.
B. SIOH	$	23178.
C. DESIGN COST	$	25285.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	422882.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	422882.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	949.	$ 3809.	11.37	43313.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	-1450.	$ -4234.	17.52	-74180.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		-501.	$ -425.		$ -30867.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 2704.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 31502.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 31502.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ -10186.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= -.10
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 2279.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 635.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .00
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 185.52

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 2812
ENERGY CONSERVATION OPPORTUNITY: ECO-17
SYSTEM MODIFICATION: DECENTALIZE BOILERS, ELEC. WATER HEATER IN EACH BLDG
SYSTEMS TO MODIFY: NEW ELEC. WATER HEATER

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-17, install electric boilers for summer DHW.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	8	38,000	7,346	7,476
ECO	184	765,000	0	2,611
Savings (Baseline-ECO)	(176)	(727,000)	7,346	4,865

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	-2481 MMBtu/Yr	X	$4.0141 /MMBtu	=	($9,960)per year
Nat. Gas:	7346 MMBtu/Yr	X	$2.92 /MMBtu	=	$21,450 per year
Total Energy Cost Savings:	**($9,960) +**		**$21,450**	**=**	**$11,490 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: -176 kW/month X $1.787 /kW X 12 months/year

= (+) ($3,774) per year

Maintenance: = (-) $0 per year

Total: ($3,774) - $0 = ($3,774) per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-1

** TOTAL **

SYSTEM C1 HEATING, COOLING, DOMESTIC HW, AND DIST. LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	27450.
PEAK DAY GAS CONSUMP., 1000 CU FT	237.
ELECTRICAL CONSUMPTION, KWH	479788.
PEAK KW DEMAND (15 MIN BASIS)	192.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	479788.
ON-PEAK KW DEMAND (15 MIN BASIS)	192.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3027
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BASELINE-2

** TOTAL **

SYSTEM C1 SUMMER HW AND DISTRIBUTION LOSS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	7348.
PEAK DAY GAS CONSUMP., 1000 CU FT	40.
ELECTRICAL CONSUMPTION, KWH	38520.
PEAK KW DEMAND (60 MIN BASIS)	8.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	38520.
ON-PEAK KW DEMAND (60 MIN BASIS)	8.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (60 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (60 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
BOILER OPERATING HOURS	
BOILER 1	5136
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 2812 BOILER ECO-3B

** TOTAL **

SYSTEM E1 ELECTRIC HW BOILER FOR EACH BLDG.

FUEL AND POWER CONSUMPTION	SYSTEM E1
TOTAL GAS CONSUMP., 1000 CU FT	0.
PEAK DAY GAS CONSUMP., 1000 CU FT	0.
ELECTRICAL CONSUMPTION, KWH	764709.
PEAK KW DEMAND (15 MIN BASIS)	184.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	764709.
ON-PEAK KW DEMAND (15 MIN BASIS)	184.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 10-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CODE A [X] CODE B [ ] CODE C [ ] OTHER ____

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO-3B BLDG. 2812	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
INSTANT ELECTRIC DHW HEATERS / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
20 kW ELECTRIC DHW HEATER	39	EA	10.0	390.0	20	7644			1163.00	45357.00	$53,001		
WIRING AND DISCONNECT - 100 AMP	39	EA	8.5	331.5	20	6497			247.00	9633.00	$16,130		
75 kVA TRANSFORMER	13	EA	26.7	346.7	20	6796			2830.00	36790.00	$43,586		
TRANSFORMER FEEDER SERVICE	13	LS							61.56	800.28	$800		
SUBTOTAL						$20,937				$92,580	$113,517		
OVERHEAD, BOND	16%					$3,350				$14,813	$18,163		
PROFIT	10%					$2,094				$9,258	$11,352		
COST SUB-TOTAL						$26,381				$116,651	$143,032		
CONTINGENCY	20%					$5,276				$23,330	$28,606		
SUBTOTAL						$31,657				$139,981	$171,638		
S&A	5.5%					$1,741				$7,699	$9,440		
TOTAL THIS SHEET						$33,398				$147,680	$181,078		

DA FORM [illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: B2812E3B
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ELECTRIC BOILER
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	171638.
B. SIOH	$	9440.
C. DESIGN COST	$	10299.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	172239.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	172239.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	-2478.	$ -9947.	11.37	-113094.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	7346.	$ 21450.	17.52	375810.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		4868.	$ 11504.		$ 262716.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -3774.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -43967.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -43967.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 86696.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 7730.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 218749.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.27
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 22.28

CENTRAL PLANT 3442

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 3442
ENERGY CONSERVATION OPPORTUNITY: ECO- 1
SYSTEM MODIFICATION: ADD INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY: CHILLER 1 AND 2 COMBINED

CALCULATION DESCRIPTION:

Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-1, install instrumentation to facilitate efficient operation of chiller plant.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	1,340,000	0	4,573
ECO	--	1,131,000	0	3,860
Savings (Baseline-ECO)	0	209,000	0	713

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	713 MMBtu/Yr	X	$4.0141 /MMBtu	=	$2,863 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$2,863**	+	**$0**	=	**$2,863 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $228 per year

Total: $0 - $228 = ($228) per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

Central Plant 3442 Baseline

** TOTAL **

SYSTEM C1 PLANT 3442 BASELINE

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	0.
PEAK DAY GAS CONSUMP., 1000 CU FT	0.
ELECTRICAL CONSUMPTION, KWH	1340162.
PEAK KW DEMAND (15 MIN BASIS)	590.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	1340162.
ON-PEAK KW DEMAND (15 MIN BASIS)	590.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	3672
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

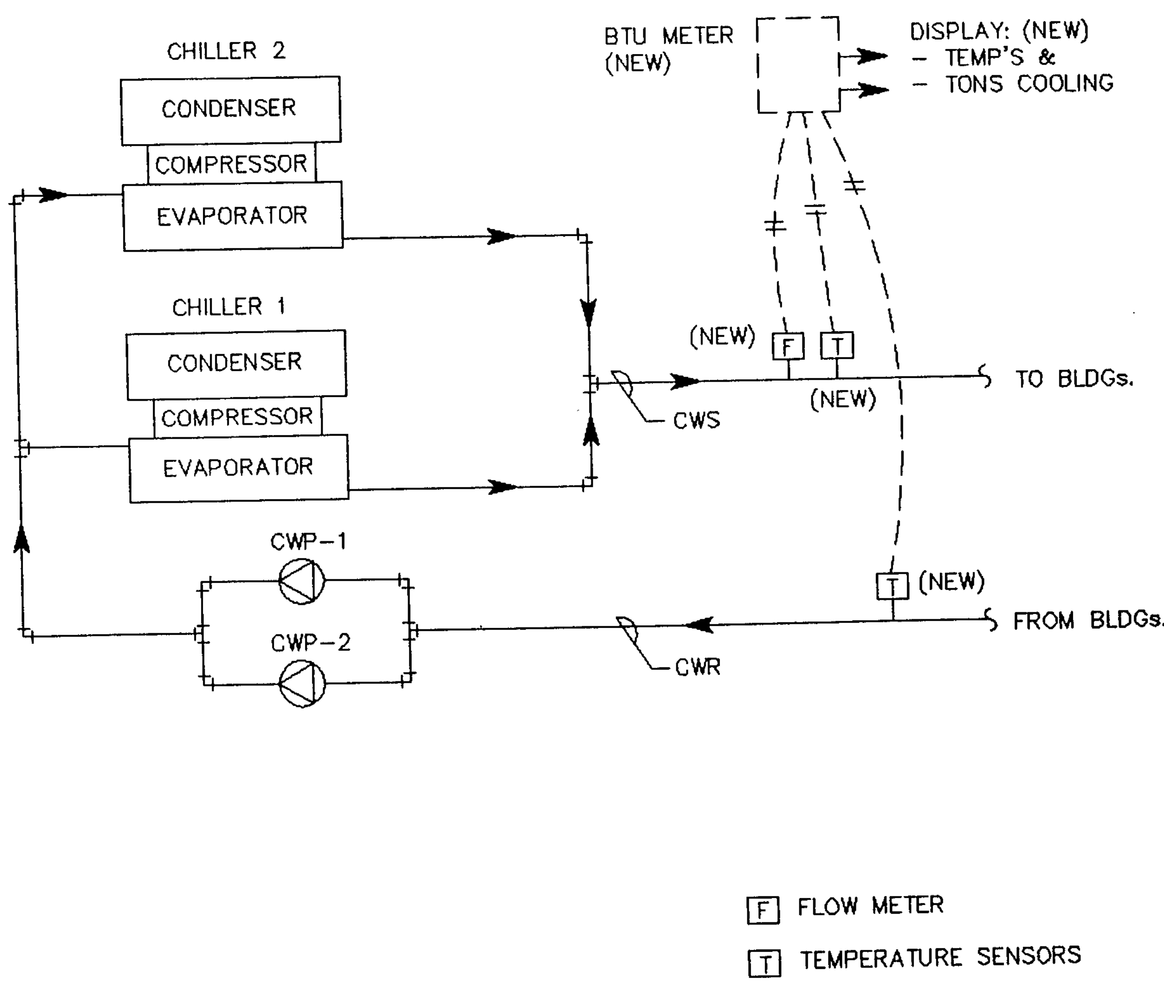
CENTRAL PLANT 3442 CHILLER ECO-1

** TOTAL **

SYSTEM C1 PLANT 3442 BASELINE

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	0.
PEAK DAY GAS CONSUMP., 1000 CU FT	0.
ELECTRICAL CONSUMPTION, KWH	1130025.
PEAK KW DEMAND (15 MIN BASIS)	614.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	1130025.
ON-PEAK KW DEMAND (15 MIN BASIS)	614.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	736
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

ECO-1, INSTRUMENTATION FOR CHILLER PLANT (TYPICAL)



[C-ECO-1.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

DRAWING NO.

SHT OF

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO-1 BLDG. 3442 INSTRUMENTATION	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 2 CHILLERS													
INSERT. FLOW METER	1	EA			$197	$197			$764	$764	$961		
BTU METER	1	EA	6.0	6.0	$20	$118			$820	$820	$938		
LED DISPLAY	2	EA							$60	$120	$120		
LED INSTALLATION	2	EA	4.6	9.2	$20	$180			$158	$316	$496		
SUBTOTAL						$495				$2,020	$2,515		
OVERHEAD, BOND	16%					$79				$323	$402		
PROFIT	10%					$49				$202	$251		
COST SUB-TOTAL						$624				$2,545	$3,169		
CONTINGENCY	20%					$125				$509	$634		
SUBTOTAL						$748				$3,054	$3,803		
S&A	5.5%					$41				$168	$209		
TOTAL THIS SHEET						$789				$3,222	$4,012		

DA FORM ... R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: C3442ECO

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.035

INSTALLATION & LOCATION: FT. SILL, OKLAHOMA   REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000   ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991   DISCRETE PORTION NAME: CHILLER INSTRUMENTATION
ANALYSIS DATE: 04-12-91   ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	3803.
B. SIOH	$	210.
C. DESIGN COST	$	229.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	3818.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	3818.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	713.	$ 2862.	8.78	25128.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	0.	$ 0.	12.48	0.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		713.	$ 2862.		$ 25128.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) — $ -228.
(1) DISCOUNT FACTOR (TABLE A) — 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) — $ -2077.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -2077.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 8292.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 2634.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 23051.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 6.04
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 1.45

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 3442
ENERGY CONSERVATION OPPORTUNITY: ECO-2
SYSTEM MODIFICATION: CHILLER OPTIMIZATION, ADD INSTRUMENTATION
SYSTEMS TO MODIFY: CHILLER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-2, install instrumentation connected to EMCS for chiller optimization.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	1,340,000	0	4,573
ECO	--	1,059,000	0	3,614
Savings (Baseline-ECO)	0	281,000	0	959

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	959 MMBtu/Yr	X	$4.0141 /MMBtu	=	$3,850 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$3,850**	+	**$0**	=	**$3,850 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $936 per year

Total: **$0** - **$936** = **($936) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

Central Plant 3442 Baseline

** TOTAL **

SYSTEM C1 PLANT 3442 BASELINE

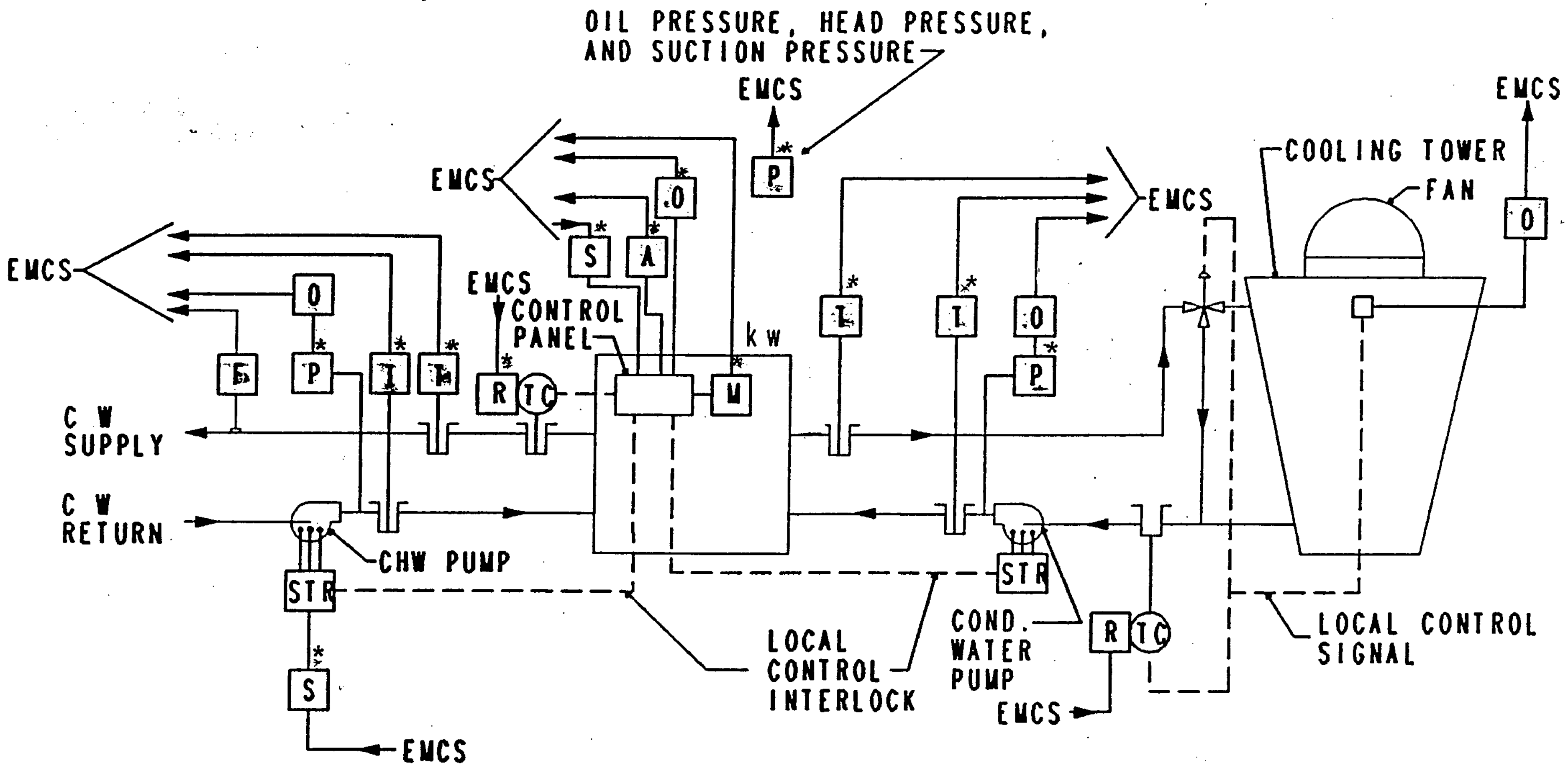
FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	0.
PEAK DAY GAS CONSUMP., 1000 CU FT	0.
ELECTRICAL CONSUMPTION, KWH	1340162.
PEAK KW DEMAND (15 MIN BASIS)	590.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	1340162.
ON-PEAK KW DEMAND (15 MIN BASIS)	590.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	3672
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 3442 CHILLER ECO-2 ** TOTAL **

SYSTEM C1 PLANT 3442 BASELINE

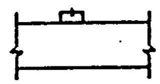
FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	0.
PEAK DAY GAS CONSUMP., 1000 CU FT	0.
ELECTRICAL CONSUMPTION, KWH	1058963.
PEAK KW DEMAND (15 MIN BASIS)	595.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	1058963.
ON-PEAK KW DEMAND (15 MIN BASIS)	595.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	664
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.



Water cooled chiller

* - Points included on proposed EMCS design, existing.
All other points are new.

→ EMCS	SIGNAL TRANSMITTED TO EMCS
← EMCS	SIGNAL TRANSMITTED FROM EMCS
$\boxed{A}$	ALARM CONTACT SIGNAL
$\boxed{E}$	ECONOMIZER CONTROL INTERFACE
$\boxed{F}$	FLOW INDICATION
$\boxed{FL}$	FLAME INDICATION
$\boxed{H}$	HUMIDITY INDICATION
$\boxed{P}$	PRESSURE INDICATION
$\boxed{LV}$	LEVEL INDICATION
$\boxed{M}$	METER
$\boxed{O}$	ON-OFF STATUS SIGNAL
$\boxed{DP}$	DIFFERENTIAL PRESSURE SWITCH
$\boxed{R}$	CONTROLLER RESET INTERFACE
$\boxed{S}$	START-STOP INTERFACE
$\boxed{T}$	TEMPERATURE INDICATION
$\boxed{V}$	VENTILATION/RECIRCULATION CONTROL
$\boxed{PS}$	POSITION
$\boxed{O_2}$	FLUE GAS ANALYSIS, OXYGEN
$\boxed{C_0}$	FLUE GAS ANALYSIS, CARBON MONOXIDE

$\boxed{FD}$	FURNACE DRAFT DIFFERENTIAL PRESSURE
$\boxed{DS}$	HIGH-LOW DEMAND SIGNAL SELECTOR
TC	TEMPERATURE CONTROLLER
PC	PRESSURE CONTROLLER
$\boxed{STR}$	MOTOR STARTER
	SENSOR INSTALLED IN THERMOMETER WELL
	SENSOR INSTALLED IN DUCT OR PLENUM
CHW	CHILLED WATER
EA	EXHAUST AIR
SA	SUPPLY AIR
RA	RETURN AIR
OA	OUTSIDE AIR
MA	MIXED AIR
WB	WET BULB
DB	DRY BULB
OAD	OUTSIDE AIR DAMPER
RAD	RETURN AIR DAMPER
EAD	EXHAUST AIR DAMPER
MZD	MULTIZONE DAMPER
RH	RELATIVE HUMIDITY

Symbols and Abbreviations

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C
[ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

DRAWING NO.

SHT OF

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO-2 BLDG. 3442	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
OPTIMIZE CHILLER SEQUENCE TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 2 CHILLERS													
CHWS/R TEMPERATURE SENSOR *	4	LS			$176	$704			$328	$1,312	$3,328		
CHWS/R TEMPERATURE SENSOR	2	LS			$176	$352			$328	$656	$1,008		
CNWS/R TEMPERATURE SENSOR *	4	LS			$176	$704			$328	$1,312	$3,328		
INSERT. FLOW METER	3	LS			$197	$591			$764	$2,292	$2,883		
CHWP ST/SP *	2	LS			$39	$78			$226	$452	$982		
CNWP ST/SP *	2	LS			$39	$78			$226	$452	$982		
DP (LIQUID) PUMP STATUS *	4	LS			$155	$620			$205	$820	$2,260		
COOLING TOWER ST/SP *	4	LS			$39	$157			$226	$904	$1,965		
COOLING TOWER ST/SP STATUS *	4	LS			$104	$416			$53	$212	$840		
CHW TEMP CONTROL *	2	EA	5.5	11.0	$20	$216			$558	$1,116	$2,448		
CHILLER ST/SP *	1	EA	2.0	2.0	$20	$39			$226	$226	$491		
kW TRANSDUCER	2	LS			$226	$452			$374	$748	$1,200		
CURRENT TRANSDUCER	2	LS			$126	$252			$270	$540	$792		
FID PANEL & ACCESSORIES	1	LS			$208	$208			$3,681	$3,681	$3,889		
FID SOFTWARE COMMISSIONING	1	EA	6.0	6.0	$45	$270					$270		
FID TESTING	1	EA	6.0	6.0	$45	$270					$270		
CREDIT FROM EMCS PROJECT *						($3,012)				($6,806)	($9,818)		
SUBTOTAL						$2,395				$7,917	$10,312		
OVERHEAD, BOND	16%					$383				$1,267	$1,650		
PROFIT	10%					$240				$792	$1,031		
COST SUB-TOTAL						$3,018				$9,975	$12,993		
CONTINGENCY	20%					$604				$1,995	$2,599		
SUBTOTAL						$3,621				$11,971	$15,592		
S&A	5.5%					$199				$658	$858		
TOTAL THIS SHEET						$3,820				$12,629	$16,449		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C3442ECO
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER OPTIMIZATION
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	15592.
B. SIOH	$	858.
C. DESIGN COST	$	936.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	15647.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	15647.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	959.	$ 3849.	8.78	33798.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	0.	$ 0.	12.48	0.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		959.	$ 3849.		$ 33798.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -936.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -8527.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -8527.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 11153.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 2913.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 25271.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.62
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 5.37

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 3442
ENERGY CONSERVATION OPPORTUNITY: ECO-4
SYSTEM MODIFICATION: INSTALL ICE STORAGE COOLING SYSTEM
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Hand calculation sheet was prepared to determine the energy savings for ECO-4, install ice storage system for HVAC cooling.
It was estimated that the peak electrical demand can be saved by installing ice storage cooling system.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	780	0	0	0

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$0**	+	**$0**	=	**$0 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 780 kW/month X $1.787 /kW X 12 months/year

= (+) $16,726 per year

Maintenance: = (-) $0 per year

Total: **$16,726** - **$0** = **$16,726 per year**

[ECO-SHT.WK3]

A new application of an old idea that can cut air conditioning energy costs in half.

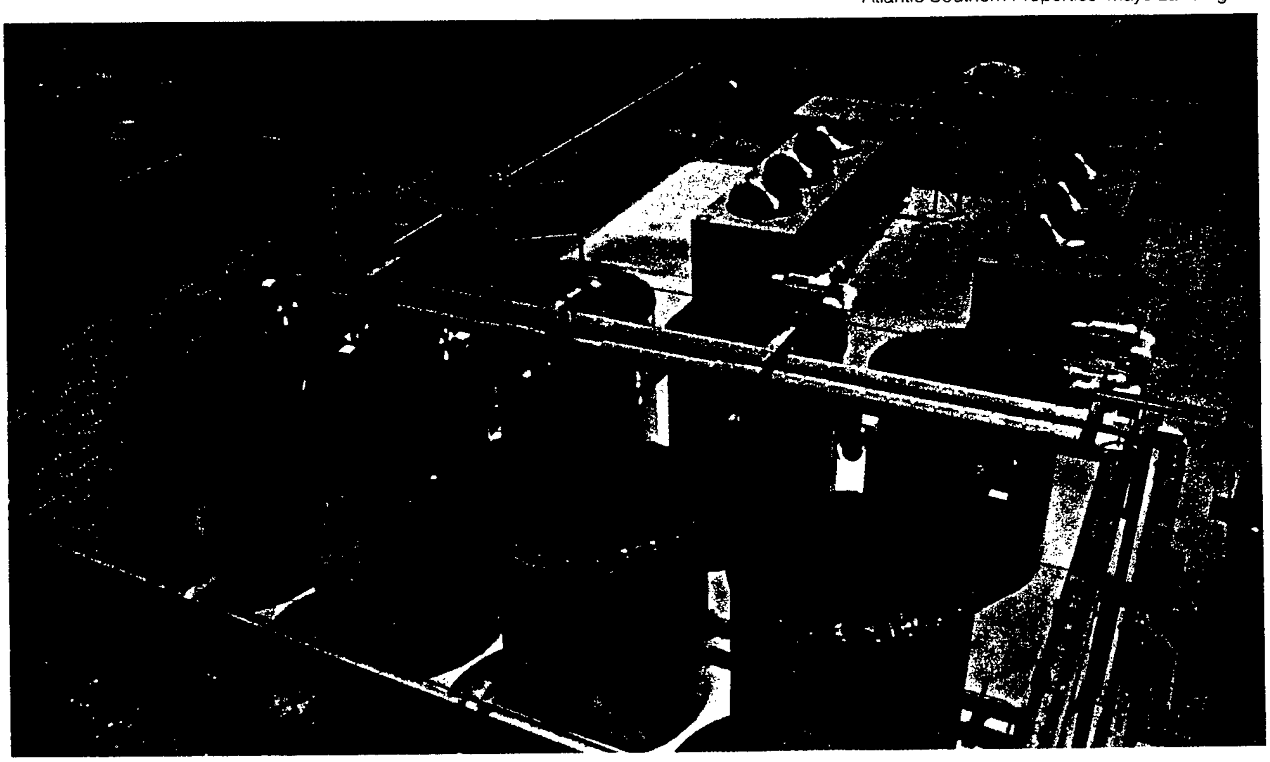
Air conditioning during summer daytime hours is the largest single contributor to utility "peak demand" charges. After noon, as more air conditioners are needed to maintain comfortable temperatures, the increased demand for electricity adds to that already created by lighting, operating equipment, computers and thousands of other uses. This requires the utility to bring additional, more costly generating sources on line to handle its increased demand. Commercial users whose large air conditioning loads contribute to these added generating requirements are assessed an additional charge based on their highest on-peak demand for electricity.

An Ice Bank Stored Cooling System is either a load-shifting or load-leveling method which will significantly lower demand charges during the air conditioning season and, consequently, energy costs. It uses a standard packaged chiller to produce solid ice at night during off-peak periods when the building's electrical needs are at a minimum. The ice is built and stored in modular ice tanks to provide cooling to help meet the building's air conditioning load requirement the following day.

Making ice at night and using its stored energy during the day is not a new or experimental idea. This concept had been employed for years in cooling short-peak applications such as churches and theatres. However, longer peak uses were served by air-source rooftop and chiller-type air conditioners which were less costly to install. Now there is renewed interest in a broad use of ice-making systems by both users and utilities as the best way to offset rising operating costs. In fact, Stored Cooling Systems are what summer-peaking utilities *must have* to avoid the unbearable costs of new generating plants.

Ice Banks not only can cut operating costs in half but they can also substantially reduce capital outlays when systems are suitably designed for new commercial and industrial buildings. Engineers can specify half-size chillers operating 24 hours a day rather than full-size chillers operating only 10 or 12 hours per day. In retrofit applications, an Ice Bank Stored Cooling System can often provide cooling for an addition to a building without adding chiller capacity.

Atlantic Southern Properties Mays Landing NJ



How the LEVLOAD System Works

The LEVLOAD Ice Bank is a modular, insulated polyethylene tank containing a spiral-wound plastic tube heat exchanger surrounded with water. They are available in four sizes – 90, 100, 190 and 570 ton-hours. At night, a 75 percent water - 25 percent glycol solution from a standard packaged air conditioning chiller circulates through the heat exchanger and extracts heat until eventually all the water in the tank is frozen solid. The ice is built uniformly throughout the tank by the patented temperature-averaging effect of closely spaced counterflow heat exchanger tubes, Figure 5. Water does not become surrounded by ice during the freezing process and can move freely as ice forms, preventing stress or damage to the tank.

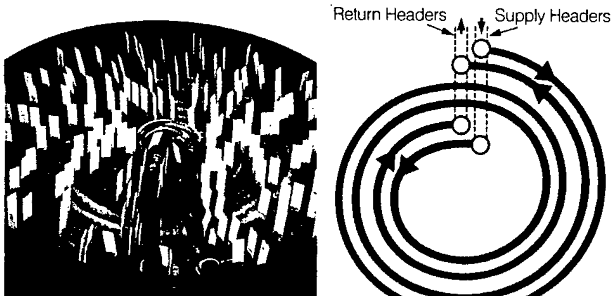


Figure 5

Typical flow diagrams for a Partial Storage System are shown in Figures 6 and 7.

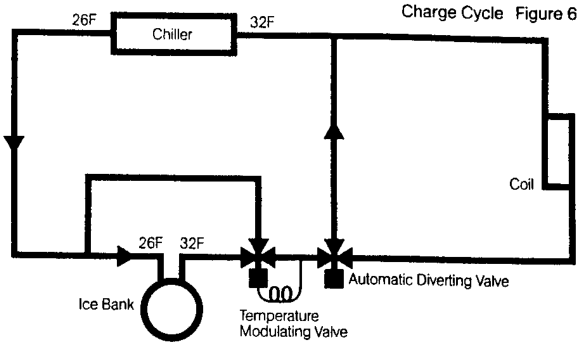
At night, the water-glycol solution circulates through the chiller and the Ice Bank heat exchanger, bypassing the air handler coil. The fluid is at 26F and freezes the water surrounding the heat exchanger.

During the day, the solution is cooled by the Ice Bank from 52F to 34F. A temperature modulating valve set at 44F in a bypass loop around the Ice Bank permits a sufficient quantity of 52F fluid to bypass the Ice Bank, mix with the 34F fluid, and achieve the desired 44F temperature. The 44F fluid enters the coil, where it cools air from 75F to 55F. The fluid leaves the coil at 60F, enters the chiller and is cooled to 52F.

It should be noted that, while making ice at night, the chiller must cool the water-glycol solution to 26F, rather than produce 44 or 45F water temperatures required for conventional air conditioning systems. This has the effect of "derating" the nominal chiller capacity by approximately 30 percent. Compressor efficiency, however, is only slightly reduced because lower nighttime temperatures result in cooler condenser water from the cooling tower and help keep the unit operating efficiently. Similarly, air cooled chillers benefit from cooler condenser entering air temperatures at night.

The temperature modulating valve in the bypass loop has the added advantage of providing unlimited capacity control. During many mild temperature days in the spring and fall, the chiller will be capable of providing all the necessary cooling for the building without assistance from stored cooling. When the building's actual cooling load is equal to or lower than the chiller capacity, all of the system coolant flows through the bypass loop, as in Figure 8.

Charge Cycle Figure 6



Discharge Cycle Figure 7

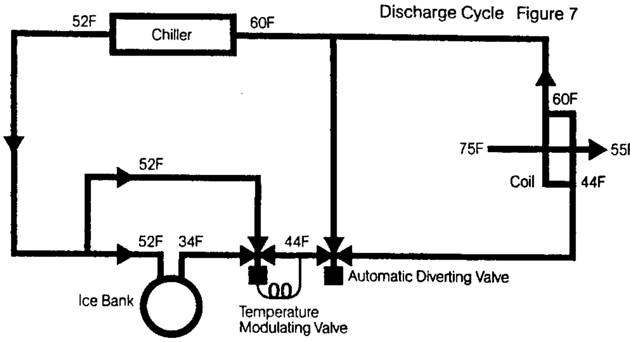
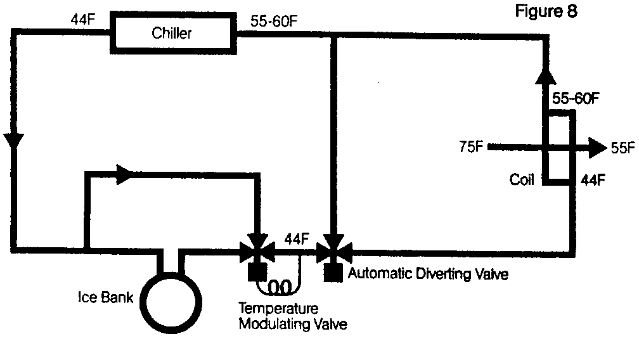


Figure 8



The glycol recommended for the solution is an ethylene glycol-based industrial coolant, such as Dow Chemical Company's Dowtherm® SR-1 or Union Carbide Corporation's UCARTHERM® which are specially formulated for low viscosity and superior heat transfer properties. These contain a multi-component corrosion inhibitor system which is effective with most materials of construction, including aluminum, copper, solder and plastics. Unlike automotive-type anti-freeze, they produce no films and contain no anti-leak agents to interfere with heat transfer efficiency and permit use of standard system pumps, seals and air handler coils. However, because of the slight difference in heat transfer coefficient between water-glycol and plain water, coil capacity should be increased by approximately 5 percent. It is also important that the water and glycol be thoroughly mixed before the solution enters the system.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 3442EC4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ICE STORAGE COOLING SYSTEM
ANALYSIS DATE: 04-18-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	288000.
B. SIOH	$	15840.
C. DESIGN COST	$	17280.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	289008.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	289008.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 16726.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 194858.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 194858.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 0.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 16726.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 194858.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .67
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 17.28

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 3442
ENERGY CONSERVATION OPPORTUNITY: ECO- 5(B)
SYSTEM MODIFICATION: VARIABLE SPEED DRIVE FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO-5, install two-speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	46,756	--	160
ECO	--	10,872	--	37
Savings (Baseline-ECO)	0	35,884	0	122

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	122 MMBtu/Yr	X	$4.0141 /MMBtu	=	$492 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$492**	**+**	**$0**	**=**	**$492 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $597 per year

Total: **$0** - **$597** = **($597) per year**

[ECO-SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input. The calculations take into account multi-cell towers (part 7). The control sequence is:

- 0-25% load, fan 1, half speed cycling.
- 25-50% load, fan 1 half speed running, fan 2 half speed cycling:
- 50-75% load, fan 1 full speed cycling, fan 2 half speed running.
- 75-100% load, fan 1 full speed running, fan 2 full speed cycling.

kWh per bin, for % design loads less than 25% load = (fan 1 power kW) * 14% * (%design load / 25) * 4 hours per bin * days per month.

kWh per bin, for % design loads 25% to 50% load = (fan 1 power kW * 14% * 4 hours per bin * days per month) * (fan 2 power kW * 14% * ((% design load - 25)/ 25)* 4 hours per bin * days per month)

kWh per bin, for % design loads 50% to 75% load = (fan 2 power kW * 14% * 4 hours per bin * days per month) * (fan 1 power kW * ((% design load - 50)/ 25) * 4 hours per bin * days per month)

kWh per bin, for % design loads 75% to 100% load = (fan 1 power kW * 4 hours per bin * days per month) + (fan 2 power kW * ((% design load - 75)/ 25) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 3442	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	77
– WATER FLOW (gpm)	3600
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	14940
HEAT REJECTION CAPACITY (Btu/min)	298800
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	40.57
TOTAL ENTHALPY	60.57
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	225594
MOTOR DATA	
– FAN 1 POWER (kW)	10
– FAN 2 POWER (kW)	10
– FAN 3 POWER (kW)	10
– FAN 4 POWER (kW)	10

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET–BULB AVERAGES (4 hour bins)						DESIGN
	1–4	5–8	9–12	13–16	17–20	21–24	WB
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	77
MAY	57.1	56.6	61.2	63.9	63	59.4	77
JUNE	66.8	66.6	69.9	71	70.5	68.2	77
JULY	70.8	70.9	74.5	76	74.9	72.6	77
AUGUST	66.9	67	71	72	71	68.5	77
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	77
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	77

ENTHALPY FOR AVERAGE WET-BULBS	1-4	5-8	9-12	13-16	17-20	21-24	DESIGN ENTHALPY
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	40.57
MAY	24.53	24.21	27.28	29.23	28.57	26.06	40.57
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	40.57
JULY	34.77	34.86	38.14	39.57	38.52	36.37	40.57
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	40.57
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	40.57
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	40.57

COOLING PROFILE OF CENTRAL PLANTS	1-4	5-8	9-12	13-16	17-20	21-24	PEAK LOAD (Btuh)
APRIL	0	0	0	0	0	0	0
MAY	0.3	0.3	0.7	0.7	0.3	0.3	10984000
JUNE	0.3	0.3	0.7	0.7	0.3	0.3	13259000
JULY	0.3	0.3	0.7	0.7	0.3	0.3	13259000
AUGUST	0.3	0.3	0.7	0.7	0.3	0.3	13259000
SEPTEMBER	0.3	0.3	0.7	0.7	0.3	0.3	13259000
OCTOBER	0	0	0	0	0	0	0

RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY	1-4	5-8	9-12	13-16	17-20	21-24	DAYS PER MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	1.8	1.8	1.7	1.6	1.6	1.7	31
JUNE	1.5	1.5	1.3	1.3	1.3	1.4	30
JULY	1.3	1.3	1.1	1.1	1.1	1.2	31
AUGUST	1.5	1.4	1.3	1.2	1.3	1.4	31
SEPTEMBER	1.5	1.5	1.4	1.4	1.4	1.5	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	% DESIGN LOAD						DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	13.8	13.7	34.8	37.0	15.5	14.4	31
JUNE	20.6	20.5	52.7	54.6	23.0	21.4	30
JULY	23.3	23.3	62.4	66.7	27.2	24.8	31
AUGUST	20.7	20.7	54.6	56.6	23.4	21.6	31
SEPTEMBER	19.7	19.6	49.4	50.9	20.9	20.0	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	SINGLE SPEED CONTROL (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	704	698	1778	1889	793	735	
JUNE	1018	1013	2603	2699	1137	1059	
JULY	1187	1191	3186	3402	1389	1265	
AUGUST	1055	1058	2789	2888	1195	1104	
SEPTEMBER	974	969	2442	2516	1035	986	
OCTOBER	0	0	0	0	0	0	
TOTAL	4938	4928	12797	13394	5549	5150	46756

	VARIABLE SPEED COOLING TOWER CYCLING (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	17	16	270	323	24	19	
JUNE	54	53	904	1007	75	61	
JULY	80	81	1551	1890	129	97	
AUGUST	56	57	1041	1156	82	65	
SEPTEMBER	47	47	746	816	57	49	
OCTOBER	0	0	0	0	0	0	
TOTAL	255	254	4512	5193	367	291	10872

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C
[ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO-4 BLDG. 3442	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
VARIABLE SPEED COOLING TOWER TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
VFD FOR FOUR 15 HP MOTOR	1	EA	4.0	4.0	20	78			5600.00	5600.00	$5,678		
VFD WIRING & CONNECTION	4	LS	4.1	16.3	20	319			20.00	80.00	$399		
WATER TEMPERATURE SENSOR	1	EA	9.0	9.0	20	176			328.00	328.00	$504		
SUBTOTAL						$573				$6,008	$6,581		
OVERHEAD, BOND	16%					$92				$961	$1,053		
PROFIT	10%					$57				$601	$658		
COST SUB-TOTAL						$723				$7,570	$8,293		
CONTINGENCY	20%					$145				$1,514	$1,659		
SUBTOTAL						$867				$9,084	$9,951		
S&A	5.5%					$48				$500	$547		
TOTAL THIS SHEET						$915				$9,584	$10,499		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 3442EC5B
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	9951.
B. SIOH	$	548.
C. DESIGN COST	$	597.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	9986.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	9986.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	122.	$ 492.	11.37	5589.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		122.	$ 492.		$ 5589.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -597.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -6955.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -6955.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1845.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -105.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -1366.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.14
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -94.74

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 3442
ENERGY CONSERVATION OPPORTUNITY: ECO-6
SYSTEM MODIFICATION: HIGH EFFICIENCY MOTOR REPLACEMENT
SYSTEMS TO MODIFY: PUMP & COOLING TOWER MOTORS

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-6, install high efficiency motors.
It was estimated that the electrical energy can be saved by installing high efficiency motors based on the motor operating hours per year.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	4	12,880	0	44

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	44 MMBtu/Yr	X	$4.0141 /MMBtu	=	$176 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$176**	+	**$0**	=	**$176 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 4 kW/month X $1.787 /kW X 12 months/year

= (+) $86 per year

Maintenance: = (-) $0 per year

Total: **$86** - **$0** = **$86 per year**

[ECO-SHT.WK3]

HIGH EFFICIENCY MOTOR REPLACEMENT

LABOR RATE:	19.6 $/hr
ELECTRIC CONS.	0.0137 $/kWH
ELECTRIC DEMAND	1.787 $/kW

BLDG. NO.	EQUIPMENT SERVE	MOTOR HP	MOTOR FLA	MEAS AMPS	MEAS PF	MEAS VOLT	EXST EFF	NEW EFF	KW SVGS	HRS/ YEAR	KWH/YR SVGS	SVGS/ YEAR
730	CWP-1	150.0	179.0	147.0	0.87	460	90.19%	95.00%	5.73	2641	15120	$330
	CWP-2	150.0	179.0	148.0	0.91	460	86.22%	95.00%	11.50	1873	21539	$542
	CNWP-1	50.0	118.0	107.0	0.98	230	80.97%	93.00%	6.67	2641	17629	$385
	CNWP-2	50.0	118.0	107.0	0.99	230	80.15%	93.00%	7.27	468	3405	$203
	CNWP-3	NI	NI	NI								
	CTM-1	30.0	71.4	70.7	0.93	230	84.60%	92.40%	2.61	702	1834	$81
	CTM-2	30.0	71.4	71.0	0.87	230	90.44%	92.40%	0.58	702	405	$18
	HWP-1	50.0	125.0	117.5	0.87	230	86.10%	93.00%	3.51	3624	12722	$250
	HWP-2	50.0	125.0	118.0	0.87	230	86.10%	93.00%	3.53	3624	12776	$251
		DEMAND CREDIT		**$888**	**MMBtu**	**292**		**TOTAL**	**41**		**85430**	**$2,058**
914	CWP-1	40.0	48.0	41.3	0.87	460	89.69%	93.00%	1.14	3672	4178	$82
	CNWP-1	15.0	19.0	14.4	0.82	460	90.15%	90.20%	0.01	3672	23	$0
	CTM-1	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	CTM-2	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	HWP-1	2.0	6.2	5.4	0.87	230	69.43%	84.00%	0.47	3624	1694	$33
	HWP-2	2.0	6.2	5.6	0.87	230	69.43%	84.00%	0.48	3624	1757	$34
		DEMAND CREDIT		**$111**	**MMBtu**	**30**		**TOTAL**	**5**		**8932**	**$233**
2812	CWP-1	20.0	27.0	23.0	0.77	460	90.07%	91.00%	0.16	3672	586	$11
	CNWP-1	25.0	31.5	26.5	0.82	460	91.18%	91.70%	0.11	3672	394	$8
	CTM-1	15.0	18.6	18.6	0.87	460	86.79%	90.20%	0.56	1167	655	$21
	HWP-1	7.5	21.6	18.5	0.87	230	74.74%	88.50%	1.33	5163	6888	$123
	HWP-2	7.5	21.6	19.0	0.87	230	74.74%	88.50%	1.37	3672	5031	$98
		DEMAND CREDIT		**$76**	**MMBtu**	**46**		**TOTAL**	**4**		**13554**	**$261**
3442	CWP-1	60.0	73.0	63.0	0.84	460	91.62%	94.50%	1.40	3672	5158	$10[illegible]
	CWP-2	60.0	73.0	63.4	0.84	460	91.62%	94.50%	1.41	3672	5191	$10[illegible]
	CNWP-1	40.0	52.0	41.0	0.78	460	92.34%	93.00%	0.20	3672	721	$14
	CNWP-2	40.0	52.0	35.8	0.78	460	92.34%	93.00%	0.17	3672	629	$12
	CTM-1	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-2	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-3	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-4	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
		DEMAND CREDIT		**$90**	**MMBtu**	**44**		**TOTAL**	**4**		**12880**	**$266**
4701	CWP-1	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CWP-2	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CNWP-1	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CNWP-2	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CTM-1	20.0	24.6	18.2	0.87	460	87.50%	91.00%	0.55	650	361	$17
	CTM-2	15.0	19.2	16.5	0.87	440	87.90%	90.20%	0.32	650	206	$10
		DEMAND CREDIT		**$65**	**MMBtu**	**16**		**TOTAL**	**3**		**4605**	**$128**
5676	HCP-1	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	HCP-2	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	10.5	9	0.79	460	84.66%	88.50%	0.29	1160	337	$11
		DEMAND CREDIT		**$94**	**MMBtu**	**83**		**TOTAL**	**4**		**24287**	**$427**
5678	HCP-1	2.0	6.5	5.9	0.83	208	76.76%	84.00%	0.20	7296	1445	$24
	HCP-2	2.0	6.5	5.7	0.83	208	76.76%	84.00%	0.19	7296	1396	$23
	HCP-3	1.5	4.8	4.5	0.83	230	70.51%	84.00%	0.34	7296	2474	$41
	HCP-4	2.0	6.3	5.8	0.83	230	71.62%	84.00%	0.39	7296	2878	$48
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	11	9.6	0.75	460	85.12%	88.50%	0.26	1139	293	$10
		DEMAND CREDIT		**$64**	**MMBtu**	**49**		**TOTAL**	**3**		**14412**	**$262**

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 10-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

☐ CODE A ☒ CODE B ☐ CODE C

☐ OTHER ______

DRAWING NO.

SHT OF

ESTIMATOR KC

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MOTOR REP. ECO BLDG. 3442 HIGH EFF. MOTOR REP.LACEMENT TASK DESCRIPTION	Quantity No. Of Units	Unit Meas	LABOR MH/ Unit	Total Hrs	Unit Price	Cost	EQUIPMENT Unit Price	Cost	MATERIAL Unit Price	Cost	TOTAL	SHIPPING Unit Wt	Total Wt
CWP-1 60.0 HP MOTOR	1	EA	10.3	10.3	20	201			3235.0	3235.00	$3,436		
CWP-2 60.0 HP MOTOR	1	EA	10.3	10.3	20	201			3235.0	3235.00	$3,436		
CNWP-1 40.0 HP MOTOR	1	EA	7.2	7.2	20	141			2212.0	2212.00	$2,353		
CNWP-2 40.0 HP MOTOR	1	EA	7.2	7.2	20	141			2212.0	2212.00	$2,353		
CTM-1 15.0 HP MOTOR	1	EA	4.5	4.5	20	88			985.0	985.00	$1,073		
CTM-2 15.0 HP MOTOR	1	EA	4.5	4.5	20	88			985.0	985.00	$1,073		
CTM-3 15.0 HP MOTOR	1	EA	4.5	4.5	20	88			985.0	985.00	$1,073		
CTM-4 15.0 HP MOTOR	1	EA	4.5	4.5	20	88			985.0	985.00	$1,073		
SUBTOTAL						$1,038				$14,834	$15,872		
OVERHEAD, BOND	16%					$166				$2,373	$2,540		
PROFIT	10%					$104				$1,483	$1,587		
COST SUB-TOTAL						$1,308				$18,691	$19,999		
CONTINGENCY	20%					$262				$3,738	$4,000		
SUBTOTAL						$1,569				$22,429	$23,998		
S&A	5.5%					$86				$1,234	$1,320		
TOTAL THIS SHEET						$1,656				$23,663	$25,318		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 3442EC6
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: HIGH EFF. MOTOR
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	23998.
B. SIOH	$	1320.
C. DESIGN COST	$	1440.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	24082.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	24082.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	44.	$ 177.	11.37	2008.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		44.	$ 177.		$ 2008.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 85.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 990.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 990.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 663.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .11
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 262.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2998.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .12
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 92.05

CENTRAL PLANT 4701

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 4701
ENERGY CONSERVATION OPPORTUNITY: ECO-1
SYSTEM MODIFICATION: ADD INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY: CHILLER 1 AND 2 COMBINED

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-1, install instrumentation to facilitate efficient operation of chiller plant.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	306,000	7,876	8,920
ECO	--	235,000	7,876	8,678
Savings (Baseline-ECO)	0	71,000	0	242

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	242 MMBtu/Yr	X	$4.0141 /MMBtu	=	$973 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$973**	**+**	**$0**	**=**	**$973 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year
= (+) $0 per year

Maintenance: = (-) $320 per year

Total: **$0** - **$320** = **($320) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 4701 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	7875.
PEAK DAY GAS CONSUMP., 1000 CU FT	99.
ELECTRICAL CONSUMPTION, KWH	305028.
PEAK KW DEMAND (15 MIN BASIS)	396.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	305028.
ON-PEAK KW DEMAND (15 MIN BASIS)	396.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
CHILLER 2	1873
BOILER OPERATING HOURS	
BOILER 1	1205
BOILER 2	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

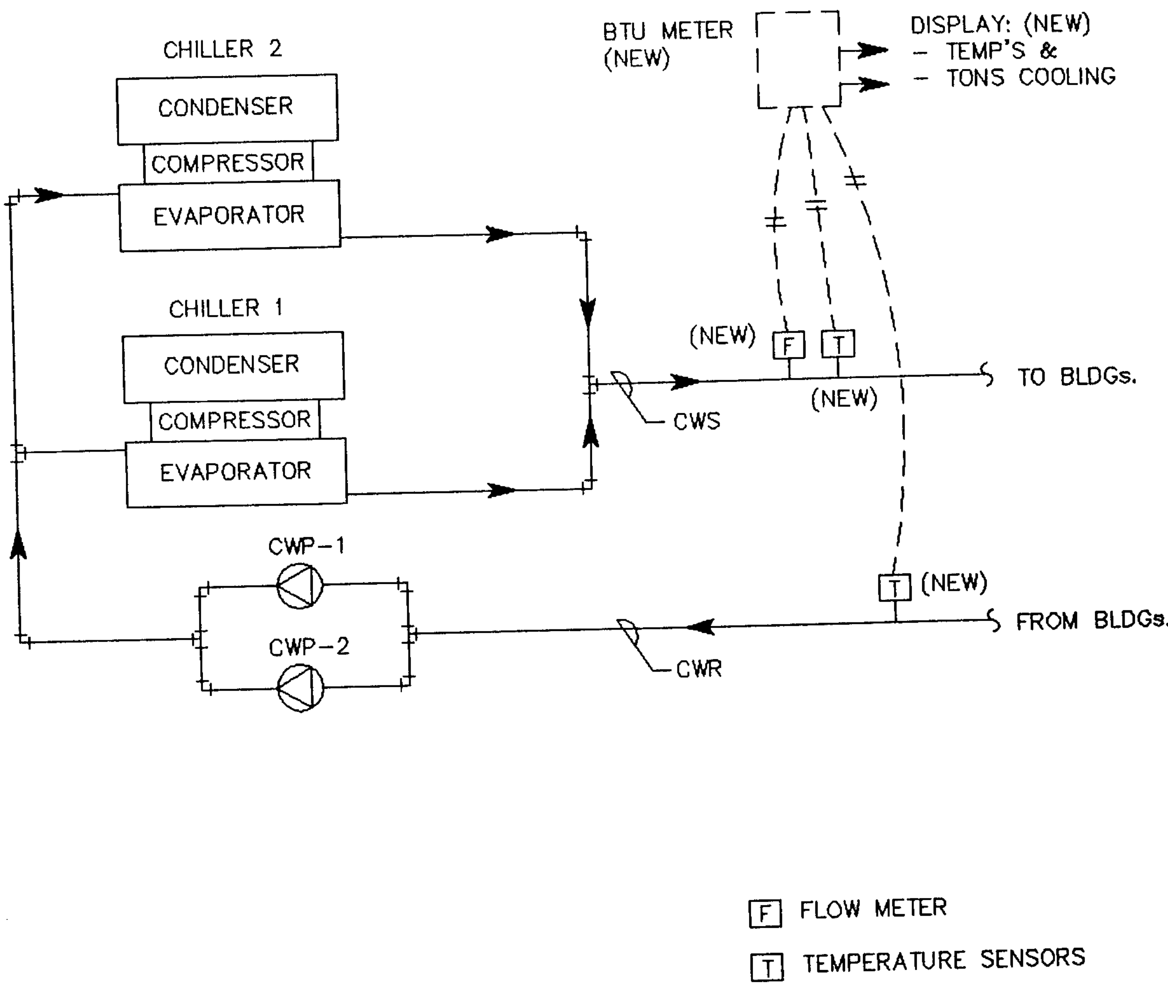
CENTRAL PLANT 4701 CHILLER ECO-1

SYSTEM C1 NORMAL HEATING AND COOLING

** TOTAL **

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	7875.
PEAK DAY GAS CONSUMP., 1000 CU FT	99.
ELECTRICAL CONSUMPTION, KWH	234767.
PEAK KW DEMAND (15 MIN BASIS)	452.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	234767.
ON-PEAK KW DEMAND (15 MIN BASIS)	452.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
CHILLER 2	87
BOILER OPERATING HOURS	
BOILER 1	1205
BOILER 2	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

ECO-1, INSTRUMENTATION FOR CHILLER PLANT (TYPICAL)



[C-ECO-1.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

[ ] CODE A [X] CODE B [ ] CODE C

[ ] OTHER ______

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO-1 BLDG. 4701	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
INSTRUMENTATION TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 2 CHILLERS													
CHWS TEMPERATURE SENSOR	1	EA			$176	$176			$328	$328	$504		
CHWR TEMPERATURE SENSOR	1	EA			$176	$176			$328	$328	$504		
INSERT. FLOW METER	1	EA			$197	$197			$764	$764	$961		
BTU METER	1	EA	6.0	6.0	$20	$118			$820	$820	$938		
LED DISPLAY	2	EA							$60	$120	$120		
LED INSTALLATION	2	EA	4.6	9.2	$20	$180			$158	$316	$496		
SUBTOTAL						$847				$2,676	$3,523		
OVERHEAD, BOND	16%					$136				$428	$564		
PROFIT	10%					$85				$268	$352		
COST SUB-TOTAL						$1,067				$3,372	$4,439		
CONTINGENCY	20%					$213				$674	$888		
SUBTOTAL						$1,281				$4,046	$5,327		
S&A	5.5%					$70				$223	$293		
TOTAL THIS SHEET						$1,351				$4,269	$5,620		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C4701ECO
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER INSTRUMENTATION
ANALYSIS DATE: 04-08-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	5327.
B. SIOH	$	293.
C. DESIGN COST	$	320.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	5346.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	5346.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	242.	$ 971.	8.78	8529.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	0.	$ 0.	12.48	0.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		242.	$ 971.		$ 8529.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 881.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 8026.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 8026.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 2814.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= 2.12
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1852.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 16555.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 3.10
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 2.89

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 4701
ENERGY CONSERVATION OPPORTUNITY: ECO-2
SYSTEM MODIFICATION: CHILLER OPTIMIZATION, ADD INSTRUMENTATION
SYSTEMS TO MODIFY: CHILLER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-2, install instrumentation connected to EMCS for chiller optimization.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	306,000	0	1,044
ECO	--	128,000	0	437
Savings (Baseline-ECO)	0	178,000	0	608

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	608 MMBtu/Yr	X	$4.0141 /MMBtu	=	$2,439 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$2,439**	+	**$0**	=	**$2,439 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand:	0 kW/month	X	$1.787 /kW	X	12 months/year
	= (+)		$0 per year		
Maintenance:	= (-)		$234 per year		
Total:	**$0**	-	**$234**	=	**($234) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 4701 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	7875.
PEAK DAY GAS CONSUMP., 1000 CU FT	99.
ELECTRICAL CONSUMPTION, KWH	305028.
PEAK KW DEMAND (15 MIN BASIS)	396.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	305028.
ON-PEAK KW DEMAND (15 MIN BASIS)	396.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
CHILLER 2	1873
BOILER OPERATING HOURS	
BOILER 1	1205
BOILER 2	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

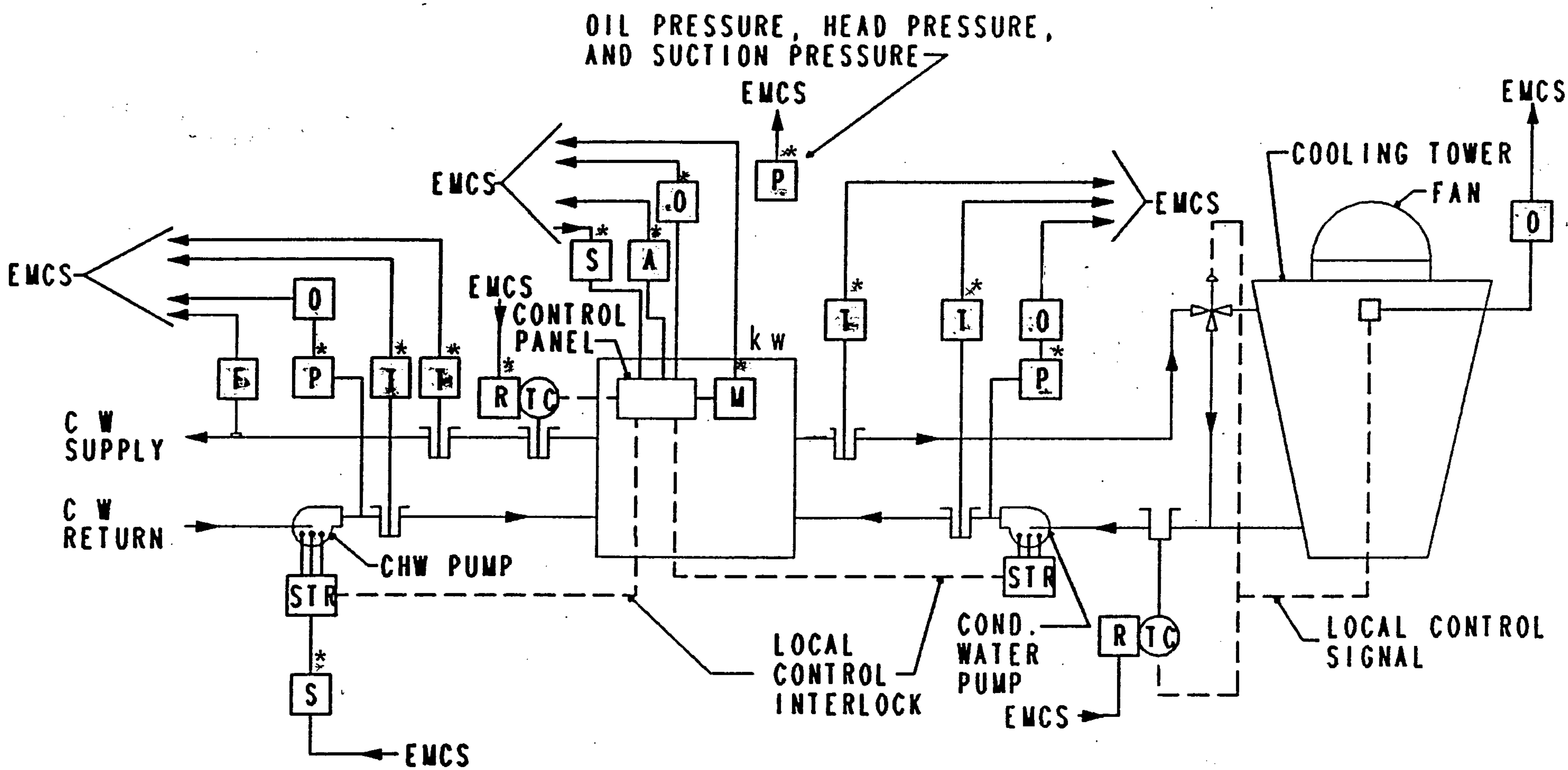
PC-CUBE VERSION 2.0.3

CENTRAL PLANT 4701 CHILLER ECO-2

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

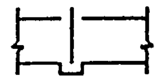
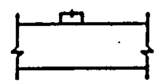
FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	7875.
PEAK DAY GAS CONSUMP., 1000 CU FT	99.
ELECTRICAL CONSUMPTION, KWH	127570.
PEAK KW DEMAND (15 MIN BASIS)	430.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	127570.
ON-PEAK KW DEMAND (15 MIN BASIS)	430.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
CHILLER 2	87
BOILER OPERATING HOURS	
BOILER 1	1205
BOILER 2	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.



Water cooled chiller

* - Points included on proposed EMCS design, existing.
All other points are new.

→ EMCS	SIGNAL TRANSMITTED TO EMCS
← EMCS	SIGNAL TRANSMITTED FROM EMCS
A	ALARM CONTACT SIGNAL
E	ECONOMIZER CONTROL INTERFACE
F	FLOW INDICATION
FL	FLAME INDICATION
H	HUMIDITY INDICATION
P	PRESSURE INDICATION
LV	LEVEL INDICATION
M	METER
O	ON-OFF STATUS SIGNAL
DP	DIFFERENTIAL PRESSURE SWITCH
R	CONTROLLER RESET INTERFACE
S	START-STOP INTERFACE
T	TEMPERATURE INDICATION
V	VENTILATION/RECIRCULATION CONTROL
PS	POSITION
O_2	FLUE GAS ANALYSIS, OXYGEN
Co	FLUE GAS ANALYSIS, CARBON MONOXIDE

FD	FURNACE DRAFT DIFFERENTIAL PRESSURE
DS	HIGH-LOW DEMAND SIGNAL SELECTOR
TC	TEMPERATURE CONTROLLER
PC	PRESSURE CONTROLLER
STR	MOTOR STARTER
	SENSOR INSTALLED IN THERMOMETER WELL
	SENSOR INSTALLED IN DUCT OR PLENUM
CHW	CHILLED WATER
EA	EXHAUST AIR
SA	SUPPLY AIR
RA	RETURN AIR
OA	OUTSIDE AIR
MA	MIXED AIR
WB	WET BULB
DB	DRY BULB
OAD	OUTSIDE AIR DAMPER
RAD	RETURN AIR DAMPER
EAD	EXHAUST AIR DAMPER
MZD	MULTIZONE DAMPER
RH	RELATIVE HUMIDITY

Symbols and Abbreviations

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ]
OTHER ____________

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO-2 BLDG. 4701 OPTIMIZE CHILLER SEQUENCE	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 2 CHILLERS													
CHWS/R TEMPERATURE SENSOR *	4	LS			$176	$704			$328	$1,312	$3,328		
CHWS/R TEMPERATURE SENSOR	2	LS			$176	$352			$328	$656	$1,008		
CNWS/R TEMPERATURE SENSOR *	4	LS			$176	$704			$328	$1,312	$3,328		
INSERT. FLOW METER	3	LS			$197	$591			$764	$2,292	$2,883		
CHWP ST/SP	2	LS			$39	$78			$226	$452	$530		
CNWP ST/SP	2	LS			$39	$78			$226	$452	$530		
DP (LIQUID) PUMP STATUS	4	LS			$155	$620			$205	$820	$1,440		
COOLING TOWER ST/SP	4	LS			$39	$157			$226	$904	$1,061		
COOLING TOWER ST/SP STATUS	4	LS			$104	$416			$53	$212	$628		
CHW TEMP CONTROL *	2	EA	5.5	11.0	$20	$216			$558	$1,116	$2,448		
CHILLER ST/SP *	2	EA	2.0	4.0	$20	$78			$226	$452	$982		
kW TRANSDUCER	2	LS			$226	$452			$374	$748	$1,200		
CURRENT TRANSDUCER	2	LS			$126	$252			$270	$540	$792		
FID PANEL & ACCESSORIES *	1	LS			$208	$208			$3,681	$3,681	$7,570		
FID SOFTWARE COMMISSIONING	1	EA	6.0	6.0	$45	$270					$270		
FID TESTING	1	EA	6.0	6.0	$45	$270					$270		
CREDIT FROM EMCS PROJECT *						($1,910)				($7,873)	($9,783)		
SUBTOTAL						$3,537				$7,076	$10,613		
OVERHEAD, BOND	16%					$566				$1,132	$1,698		
PROFIT	10%					$354				$708	$1,061		
COST SUB-TOTAL						$4,456				$8,916	$13,372		
CONTINGENCY	20%					$891				$1,783	$2,674		
SUBTOTAL						$5,347				$10,699	$16,046		
S&A	5.5%					$294				$588	$883		
TOTAL [illegible]S SHEET						$5,641				$11,287	$16,929		

DA FORM [illegible], APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C4701ECO
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER OPTIMIZATION
ANALYSIS DATE: 04-08-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	16046.
B. SIOH	$	883.
C. DESIGN COST	$	963.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	16103.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	16103.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	608.	$ 2441.	8.78	21428.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	0.	$ 0.	12.48	0.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		608.	$ 2441.		$ 21428.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -234.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -2132.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -2132.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 7071.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 2207.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 19296.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.20
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 7.30

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 4701
ENERGY CONSERVATION OPPORTUNITY: ECO-3
SYSTEM MODIFICATIOIN: CHILLER REPLACEMENT
SYSTEMS TO MODIFY: CHILLER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-3, renovate or replace existing chillers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	396	306,000	--	1,044
ECO	283	180,000	--	614
Savings (Baseline-ECO)	113	126,000	0	430

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	430 MMBtu/Yr	X	$4.0141 /MMBtu	=	$1,726 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$1,726**	+	**$0**	=	**$1,726 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 113 kW/month X $1.787 /kW X 12 months/year

= (+) $2,423 per year

Maintenance: = (-) $3,000 per year

Total: $2,423 - $3,000 = ($577) per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 4701 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	7875.
PEAK DAY GAS CONSUMP., 1000 CU FT	99.
ELECTRICAL CONSUMPTION, KWH	305028.
PEAK KW DEMAND (15 MIN BASIS)	396.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	305028.
ON-PEAK KW DEMAND (15 MIN BASIS)	396.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
CHILLER 2	1873
BOILER OPERATING HOURS	
BOILER 1	1205
BOILER 2	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 09-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CODE A [ ] X CODE B [ ] CODE C [ ] OTHER ______

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO-3 BLDG. 4701	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
HIGH EFFICIENCY CHILLERS / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CHILLER REPLACEMENT													
305 TON CHILLER	2	EA	64.0	128.0	24	3072	550	1100	65480	130960	135132		
REMOVE EXISTING CHILLER	2	LS	36.0	72.0	24	1728					$1,728		
SUBTOTAL						$4,800		$1,100		$130,960	$136,860		
OVERHEAD, BOND	16%					$768		$176		$20,954	$21,898		
PROFIT	10%					$480		$110		$13,096	$13,686		
COST SUB-TOTAL						$6,048		$1,386		$165,010	$172,444		
CONTINGENCY	20%					$1,210		$277		$33,002	$34,489		
SUBTOTAL						$7,258		$1,663		$198,012	$206,932		
S&A	5.5%					$399		$91		$10,891	$11,381		
TOTA[illegible]IS SHEET						$7,657		$1,755		$208,902	$218,314		

DA FOR[illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C4701EC3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER REPLACEMENT
ANALYSIS DATE: 04-09-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	206932.
B. SIOH	$	11382.
C. DESIGN COST	$	12416.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	207657.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	207657.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	430.	$ 1726.	11.37	19627.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		430.	$ 1726.		$ 19627.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -577.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -6722.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -6722.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 6477.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1149.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 12905.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .06
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 180.69

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 4701
ENERGY CONSERVATION OPPORTUNITY: ECO- 4
SYSTEM MODIFICATION: INSTALL ICE STORAGE COOLING SYSTEM
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Hand calculation sheet was prepared to determine the energy savings for ECO-4, install ice storage system for HVAC cooling.
It was estimated that the peak electrical demand can be saved by installing ice storage cooling system.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	583	0	0	0

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$0**	+	**$0**	=	**$0 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 583 kW/month X $1.787 /kW X 12 months/year

= (+) $12,502 per year

Maintenance: = (-) $0 per year

Total: $12,502 - $0 = $12,502 per year

[ECO-SHT.WK3]

A new application of an old idea that can cut air conditioning energy costs in half.

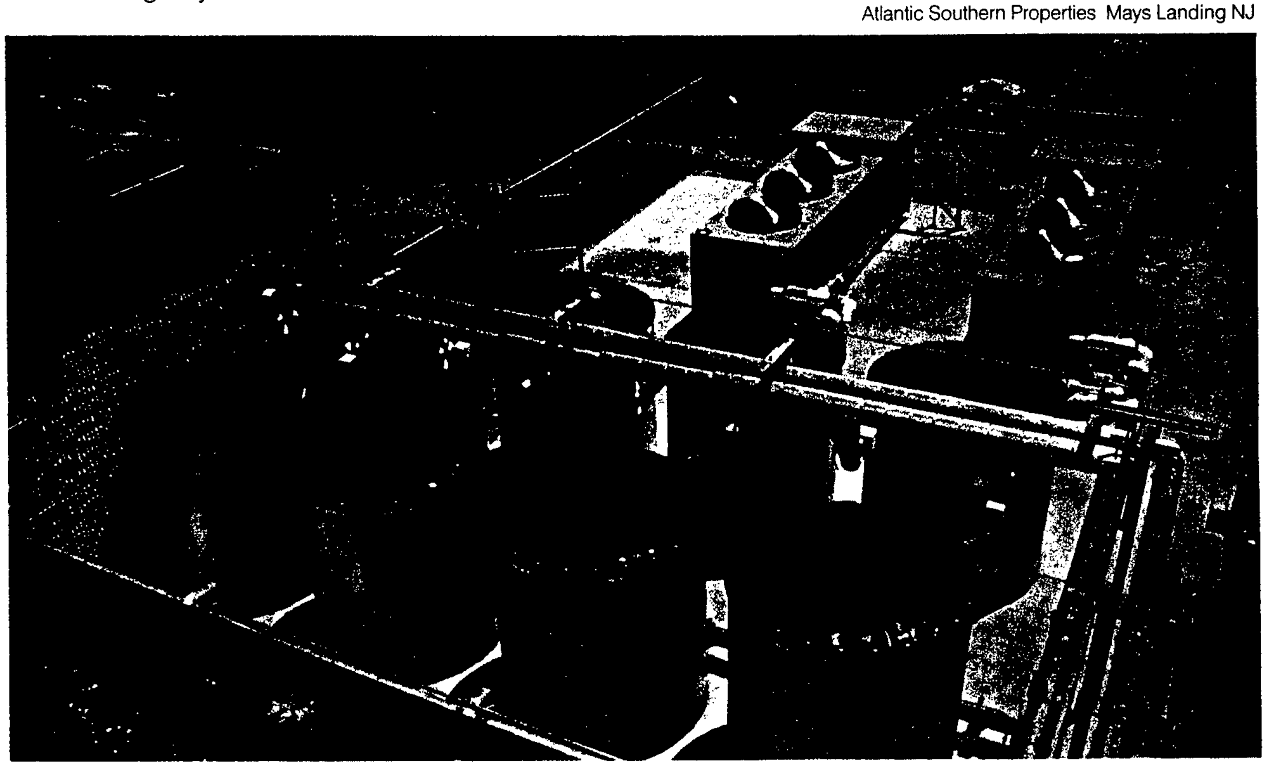
Air conditioning during summer daytime hours is the largest single contributor to utility "peak demand" charges. After noon, as more air conditioners are needed to maintain comfortable temperatures, the increased demand for electricity adds to that already created by lighting, operating equipment, computers and thousands of other uses. This requires the utility to bring additional, more costly generating sources on line to handle its increased demand. Commercial users whose large air conditioning loads contribute to these added generating requirements are assessed an additional charge based on their highest on-peak demand for electricity.

An Ice Bank Stored Cooling System is either a load-shifting or load-leveling method which will significantly lower demand charges during the air conditioning season and, consequently, energy costs. It uses a standard packaged chiller to produce solid ice at night during off-peak periods when the building's electrical needs are at a minimum. The ice is built and stored in modular ice tanks to provide cooling to help meet the building's air conditioning load requirement the following day.

Making ice at night and using its stored energy during the day is not a new or experimental idea. This concept had been employed for years in cooling short-peak applications such as churches and theatres. However, longer peak uses were served by air-source rooftop and chiller-type air conditioners which were less costly to install. Now there is renewed interest in a broad use of ice-making systems by both users and utilities as the best way to offset rising operating costs. In fact, Stored Cooling Systems are what summer-peaking utilities *must have* to avoid the unbearable costs of new generating plants.

Ice Banks not only can cut operating costs in half but they can also substantially reduce capital outlays when systems are suitably designed for new commercial and industrial buildings. Engineers can specify half-size chillers operating 24 hours a day rather than full-size chillers operating only 10 or 12 hours per day. In retrofit applications, an Ice Bank Stored Cooling System can often provide cooling for an addition to a building without adding chiller capacity.

Atlantic Southern Properties Mays Landing NJ



How the LEVLOAD System Works

The LEVLOAD Ice Bank is a modular, insulated polyethylene tank containing a spiral-wound plastic tube heat exchanger surrounded with water. They are available in four sizes – 90, 100, 190 and 570 ton-hours. At night, a 75 percent water - 25 percent glycol solution from a standard packaged air conditioning chiller circulates through the heat exchanger and extracts heat until eventually all the water in the tank is frozen solid. The ice is built uniformly throughout the tank by the patented temperature-averaging effect of closely spaced counterflow heat exchanger tubes, Figure 5. Water does not become surrounded by ice during the freezing process and can move freely as ice forms, preventing stress or damage to the tank.

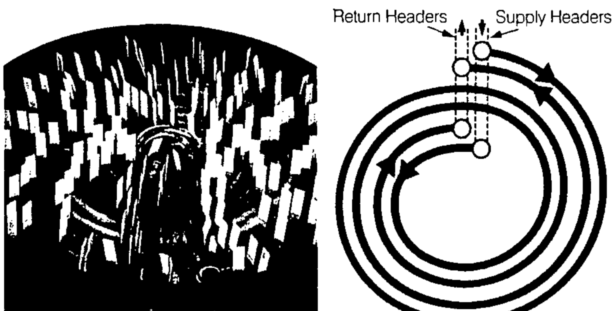


Figure 5

Typical flow diagrams for a Partial Storage System are shown in Figures 6 and 7.

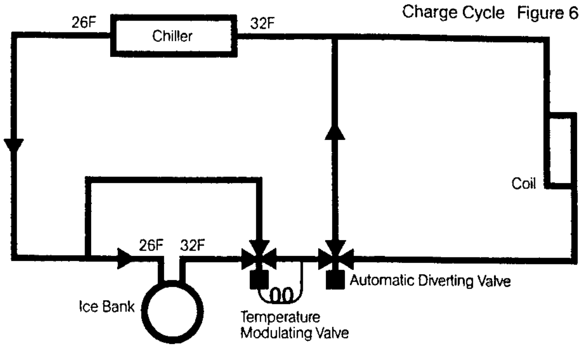
At night, the water-glycol solution circulates through the chiller and the Ice Bank heat exchanger, bypassing the air handler coil. The fluid is at 26F and freezes the water surrounding the heat exchanger.

During the day, the solution is cooled by the Ice Bank from 52F to 34F. A temperature modulating valve set at 44F in a bypass loop around the Ice Bank permits a sufficient quantity of 52F fluid to bypass the Ice Bank, mix with the 34F fluid, and achieve the desired 44F temperature. The 44F fluid enters the coil, where it cools air from 75F to 55F. The fluid leaves the coil at 60F, enters the chiller and is cooled to 52F.

It should be noted that, while making ice at night, the chiller must cool the water-glycol solution to 26F, rather than produce 44 or 45F water temperatures required for conventional air conditioning systems. This has the effect of "derating" the nominal chiller capacity by approximately 30 percent. Compressor efficiency, however, is only slightly reduced because lower nighttime temperatures result in cooler condenser water from the cooling tower and help keep the unit operating efficiently. Similarly, air cooled chillers benefit from cooler condenser entering air temperatures at night.

The temperature modulating valve in the bypass loop has the added advantage of providing unlimited capacity control. During many mild temperature days in the spring and fall, the chiller will be capable of providing all the necessary cooling for the building without assistance from stored cooling. When the building's actual cooling load is equal to or lower than the chiller capacity, all of the system coolant flows through the bypass loop, as in Figure 8.

Charge Cycle Figure 6



Discharge Cycle Figure 7

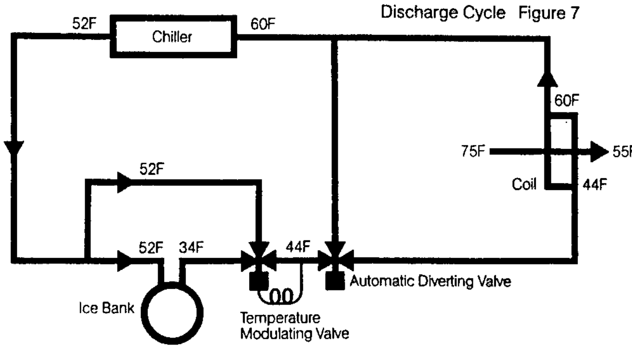
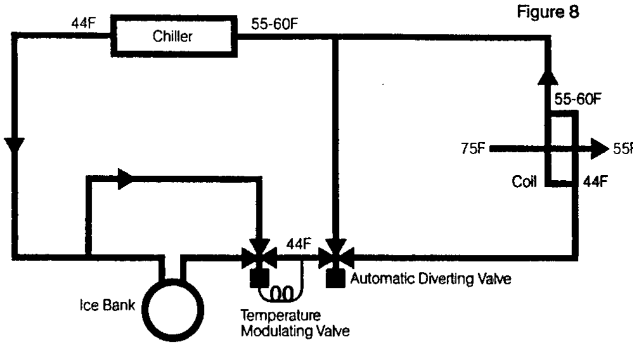


Figure 8



The glycol recommended for the solution is an ethylene glycol-based industrial coolant, such as Dow Chemical Company's Dowtherm® SR-1 or Union Carbide Corporation's UCARTHERM,® which are specially formulated for low viscosity and superior heat transfer properties. These contain a multi-component corrosion inhibitor system which is effective with most materials of construction, including aluminum, copper, solder and plastics. Unlike automotive-type anti-freeze, they produce no films and contain no anti-leak agents to interfere with heat transfer efficiency and permit use of standard system pumps, seals and air handler coils. However, because of the slight difference in heat transfer coefficient between water-glycol and plain water, coil capacity should be increased by approximately 5 percent. It is also important that the water and glycol be thoroughly mixed before the solution enters the system.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 4701EC4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ICE STORAGE COOLING SYSTEM
ANALYSIS DATE: 04-18-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	132000.
B. SIOH	$	7260.
C. DESIGN COST	$	7920.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	132462.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	132462.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 12502.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 145648.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 145648.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 0.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 12502.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 145648.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.10
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 10.60

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 4701
ENERGY CONSERVATION OPPORTUNITY: ECO– 5(B)
SYSTEM MODIFICATION: VARIABLE SPEED DRIVE FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO–5, install two–speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	––	29,264	––	100
ECO	––	11,811	––	40
Savings (Baseline–ECO)	0	17,453	0	60

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	60 MMBtu/Yr	X	$4.0141 /MMBtu	=	$239 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$239**	+	**$0**	=	**$239 per year**

NON–ENERGY SAVINGS (+), COST (–):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (–) $1,013 per year

Total: $0 – $1,013 = ($1,013) per year

[ECO–SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input. The calculations take into account multi-cell towers (part 7). The control sequence is:

- 0-25% load, fan 1, half speed cycling.
- 25-50% load, fan 1 half speed running, fan 2 half speed cycling:
- 50-75% load, fan 1 full speed cycling, fan 2 half speed running.
- 75-100% load, fan 1 full speed running, fan 2 full speed cycling.

kWh per bin, for % design loads less than 25% load = (fan 1 power kW) * 14% * (%design load / 25) * 4 hours per bin * days per month.

kWh per bin, for % design loads 25% to 50% load = (fan 1 power kW * 14% * 4 hours per bin * days per month) * (fan 2 power kW * 14% * ((% design load - 25)/ 25)* 4 hours per bin * days per month)

kWh per bin, for % design loads 50% to 75% load = (fan 2 power kW * 14% * 4 hours per bin * days per month) * (fan 1 power kW * ((% design load - 50)/ 25) * 4 hours per bin * days per month)

kWh per bin, for % design loads 75% to 100% load = (fan 1 power kW * 4 hours per bin * days per month) + (fan 2 power kW * ((% design load - 75)/ 25) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 4701	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	78
– WATER FLOW (gpm)	1650
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	6847.5
HEAT REJECTION CAPACITY (Btu/min)	136950
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	41.58
TOTAL ENTHALPY	61.58
EXIT AIR WB (LOOK UP)	93.9
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	103397
MOTOR DATA	
– FAN 1 POWER (kW)	10.5
– FAN 2 POWER (kW)	10.5
– FAN 3 POWER (kW)	12.0
– FAN 4 POWER (kW)	12.0

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET–BULB AVERAGES (4 hour bins)						DESIGN
	1–4	5–8	9–12	13–16	17–20	21–24	WB
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	78
MAY	57.1	56.6	61.2	63.9	63	59.4	78
JUNE	66.8	66.6	69.9	71	70.5	68.2	78
JULY	70.8	70.9	74.5	76	74.9	72.6	78
AUGUST	66.9	67	71	72	71	68.5	78
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	78
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	78

	ENTHALPY FOR AVERAGE WET-BULBS						DESIGN
	1-4	5-8	9-12	13-16	17-20	21-24	ENTHALPY
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	41.58
MAY	24.53	24.21	27.28	29.23	28.57	26.06	41.58
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	41.58
JULY	34.77	34.86	38.14	39.57	38.52	36.37	41.58
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	41.58
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	41.58
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	41.58

	COOLING PROFILE OF CENTRAL PLANTS						PEAK LOAD
	1-4	5-8	9-12	13-16	17-20	21-24	(Btuh)
APRIL	0	0	0	0	0	0	0
MAY	0	0.9	0.6	0.8	0	0	1465000
JUNE	0	0.9	0.6	0.8	0	0	4316000
JULY	0	0.9	0.6	0.8	0	0	4316000
AUGUST	0	0.9	0.6	0.8	0	0	4316000
SEPTEMBER	0	0.9	0.6	0.8	0	0	4316000
OCTOBER	0	0	0	0	0	0	0

	RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY						DAYS PER
	1-4	5-8	9-12	13-16	17-20	21-24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	22
MAY	1.9	1.9	1.7	1.6	1.7	1.8	23
JUNE	1.5	1.5	1.4	1.3	1.4	1.4	22
JULY	1.3	1.3	1.2	1.1	1.2	1.3	23
AUGUST	1.5	1.5	1.3	1.3	1.3	1.4	23
SEPTEMBER	1.6	1.6	1.5	1.4	1.5	1.6	22
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	23

% DESIGN LOAD							DAYS PER MONTH OPER.
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	22
MAY	0.0	16.3	11.9	16.8	0.0	0.0	23
JUNE	0.0	59.5	43.5	60.1	0.0	0.0	22
JULY	0.0	67.4	51.2	72.7	0.0	0.0	23
AUGUST	0.0	60.1	45.1	62.1	0.0	0.0	23
SEPTEMBER	0.0	57.0	40.9	56.2	0.0	0.0	22
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	23

SINGLE SPEED CONTROL (kWh)							DAYS PER MONTH OPER.
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	0	0	0	0	0	0	23
MAY	0	677	492	695	0	0	22
JUNE	0	2355	1724	2379	0	0	23
JULY	0	2789	2119	3010	0	0	23
AUGUST	0	2487	1866	2572	0	0	22
SEPTEMBER	0	2256	1620	2224	0	0	23
OCTOBER	0	0	0	0	0	0	0
TOTAL	0	10564	7820	10880	0	0	29264

VARIABLE SPEED COOLING TOWER CYCLING (kWh)							TOTAL (kWh)
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	0	0	0	0	0	0	
MAY	0	23	9	24	0	0	
JUNE	0	1041	408	1074	0	0	
JULY	0	1582	694	1988	0	0	
AUGUST	0	1122	474	1241	0	0	
SEPTEMBER	0	915	339	877	0	0	
OCTOBER	0	0	0	0	0	0	
TOTAL	0	4683	1924	5204	0	0	11811

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CODE A [X] CODE B [ ] CODE C

OTHER

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO BLDG. 4701	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
VARIABLE SPEED COOLING TOWER TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
VFD FOR TWO 20 HP MOTOR	1	EA	4.0	4.0	20	78			5600.00	5600.00	$5,678		
VFD FOR TWO 15 HP MOTOR	1	EA	4.0	4.0	20	78			4000.00	4000.00	$4,078		
VFD WIRING & CONNECTION	4	LS	4.1	16.3	20	319			20.00	80.00	$399		
WATER TEMPERATURE SENSOR	2	EA	9.0	18.0	20	352			328.00	656.00	$1,008		
SUBTOTAL						$828				$10,336	$11,164		
OVERHEAD, BOND	16%					$132				$1,654	$1,786		
PROFIT	10%					$83				$1,034	$1,116		
COST SUB-TOTAL						$1,043				$13,023	$14,066		
CONTINGENCY	20%					$209				$2,605	$2,813		
SUBTOTAL						$1,252				$15,628	$16,880		
S&A	5.5%					$69				$860	$928		
TOTA[illegible]HIS SHEET						$1,321				$16,488	$17,808		

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LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 4701EC5B
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	16880.
B. SIOH	$	929.
C. DESIGN COST	$	1013.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	16940.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	16940.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	60.	$ 239.	11.37	2719.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		60.	$ 239.		$ 2719.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1013.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -11801.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -11801.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 897.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -774.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -9083.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.54
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -21.89

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 4701
ENERGY CONSERVATION OPPORTUNITY: ECO- 6
SYSTEM MODIFICATION: HIGH EFFICIENCY MOTOR REPLACEMENT
SYSTEMS TO MODIFY: PUMP & COOLING TOWER MOTORS

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO–6, install high efficiency motors.
It was estimated that the electrical energy can be saved by installing high efficiency motors based on the motor operating hours per year.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline–ECO)	3	4,605	0	16

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	16 MMBtu/Yr	X	$4.0141 /MMBtu	=	$63 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$63**	+	**$0**	=	**$63 per year**

NON–ENERGY SAVINGS (+), COST (–):

Demand: 3 kW/month X $1.787 /kW X 12 months/year

= (+) $64 per year

Maintenance: = (–) $0 per year

Total: **$64** – **$0** = **$64 per year**

[ECO–SHT.WK3]

HIGH EFFICIENCY
MOTOR REPLACEMENT

LABOR RATE:	19.6	$/hr
ELECTRIC CONS.	0.0137	$/kWH
ELECTRIC DEMAND	1.787	$/kW

BLDG. NO.	EQUIPMENT SERVE	MOTOR HP	MOTOR FLA	MEAS AMPS	MEAS PF	MEAS VOLT	EXST EFF	NEW EFF	KW SVGS	HRS/ YEAR	KWH/YR SVGS	SVGS/ YEAR
730	CWP-1	150.0	179.0	147.0	0.87	460	90.19%	95.00%	5.73	2641	15120	$330
	CWP-2	150.0	179.0	148.0	0.91	460	86.22%	95.00%	11.50	1873	21539	$542
	CNWP-1	50.0	118.0	107.0	0.98	230	80.97%	93.00%	6.67	2641	17629	$385
	CNWP-2	50.0	118.0	107.0	0.99	230	80.15%	93.00%	7.27	468	3405	$203
	CNWP-3	NI	NI	NI								
	CTM-1	30.0	71.4	70.7	0.93	230	84.60%	92.40%	2.61	702	1834	$81
	CTM-2	30.0	71.4	71.0	0.87	230	90.44%	92.40%	0.58	702	405	$18
	HWP-1	50.0	125.0	117.5	0.87	230	86.10%	93.00%	3.51	3624	12722	$250
	HWP-2	50.0	125.0	118.0	0.87	230	86.10%	93.00%	3.53	3624	12776	$251
		DEMAND CREDIT		**$888**	**MMBtu**	**292**		**TOTAL**	**41**		**85430**	**$2,058**
914	CWP-1	40.0	48.0	41.3	0.87	460	89.69%	93.00%	1.14	3672	4178	$82
	CNWP-1	15.0	19.0	14.4	0.82	460	90.15%	90.20%	0.01	3672	23	$0
	CTM-1	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	CTM-2	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	HWP-1	2.0	6.2	5.4	0.87	230	69.43%	84.00%	0.47	3624	1694	$33
	HWP-2	2.0	6.2	5.6	0.87	230	69.43%	84.00%	0.48	3624	1757	$34
		DEMAND CREDIT		**$111**	**MMBtu**	**30**		**TOTAL**	**5**		**8932**	**$233**
2812	CWP-1	20.0	27.0	23.0	0.77	460	90.07%	91.00%	0.16	3672	586	$11
	CNWP-1	25.0	31.5	26.5	0.82	460	91.18%	91.70%	0.11	3672	394	$8
	CTM-1	15.0	18.6	18.6	0.87	460	86.79%	90.20%	0.56	1167	655	$21
	HWP-1	7.5	21.6	18.5	0.87	230	74.74%	88.50%	1.33	5163	6888	$123
	HWP-2	7.5	21.6	19.0	0.87	230	74.74%	88.50%	1.37	3672	5031	$98
		DEMAND CREDIT		**$76**	**MMBtu**	**46**		**TOTAL**	**4**		**13554**	**$261**
3442	CWP-1	60.0	73.0	63.0	0.84	460	91.62%	94.50%	1.40	3672	5158	$101
	CWP-2	60.0	73.0	63.4	0.84	460	91.62%	94.50%	1.41	3672	5191	$101
	CNWP-1	40.0	52.0	41.0	0.78	460	92.34%	93.00%	0.20	3672	721	$14
	CNWP-2	40.0	52.0	35.8	0.78	460	92.34%	93.00%	0.17	3672	629	$12
	CTM-1	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-2	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-3	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-4	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
		DEMAND CREDIT		**$90**	**MMBtu**	**44**		**TOTAL**	**4**		**12880**	**$266**
4701	CWP-1	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CWP-2	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CNWP-1	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CNWP-2	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CTM-1	20.0	24.6	18.2	0.87	460	87.50%	91.00%	0.55	650	361	$17
	CTM-2	15.0	19.2	16.5	0.87	440	87.90%	90.20%	0.32	650	206	$10
		DEMAND CREDIT		**$65**	**MMBtu**	**16**		**TOTAL**	**3**		**4605**	**$128**
5676	HCP-1	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	HCP-2	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	10.5	9	0.79	460	84.66%	88.50%	0.29	1160	337	$11
		DEMAND CREDIT		**$94**	**MMBtu**	**83**		**TOTAL**	**4**		**24287**	**$427**
5678	HCP-1	2.0	6.5	5.9	0.83	208	76.76%	84.00%	0.20	7296	1445	$24
	HCP-2	2.0	6.5	5.7	0.83	208	76.76%	84.00%	0.19	7296	1396	$23
	HCP-3	1.5	4.8	4.5	0.83	230	70.51%	84.00%	0.34	7296	2474	$41
	HCP-4	2.0	6.3	5.8	0.83	230	71.62%	84.00%	0.39	7296	2878	$48
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	11	9.6	0.75	460	85.12%	88.50%	0.26	1139	293	$10
		DEMAND CREDIT		**$64**	**MMBtu**	**49**		**TOTAL**	**3**		**14412**	**$262**

COST ESTIMATE ANALYSIS

PROJECT: ENERGY SURVEY OF ARMY BOILER AND CHILLER	INVITATION NO./CONTRACT NO. DACA 59-90-C-0087	EFFECTIVE PRICING DATE APR. 91	DATE PREPARED 10-Apr-91
LOCATION: FT. SILL, OKLAHOMA	CODE A [X] CODE B [ ] CODE C [ ] OTHER	DRAWING NO.	SHT OF
		ESTIMATOR KC	CHECKED BY CEL

MOTOR REP. ECO BLDG. 4701	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
HIGH EFF. MOTOR REP.LACEMENT TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CWP-1 50.0 HP MOTOR	1	EA	9.0	9.0	20	176			2579.0	2579.00	$2,755		
CWP-2 50.0 HP MOTOR	1	EA	9.0	9.0	20	176			2579.0	2579.00	$2,755		
CNWP-1 30.0 HP MOTOR	1	EA	6.0	6.0	20	117			1639.0	1639.00	$1,756		
CNWP-2 30.0 HP MOTOR	1	EA	6.0	6.0	20	117			1639.0	1639.00	$1,756		
CTM-1 20.0 HP MOTOR	1	EA	5.5	5.5	20	109			1189.0	1189.00	$1,298		
CTM-2 15.0 HP MOTOR	1	EA	4.5	4.5	20	88			985.0	985.00	$1,073		
SUBTOTAL						$785				$10,610	$11,395		
OVERHEAD, BOND	16%					$126				$1,698	$1,823		
PROFIT	10%					$78				$1,061	$1,139		
COST SUB-TOTAL						$989				$13,369	$14,357		
CONTINGENCY	20%					$198				$2,674	$2,871		
SUBTOTAL						$1,186				$16,042	$17,229		
S&A	5.5%					$65				$882	$948		
TOTAL THIS SHEET						$1,252				$16,925	$18,176		

DA FORM [illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 4701EC6
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: HIGH EFF. MOTOR
ANALYSIS DATE: 04-10-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	17229.
B. SIOH	$	948.
C. DESIGN COST	$	1034.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	17290.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	17290.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	16.	$ 63.	11.37	717.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		16.	$ 63.		$ 717.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 64.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 746.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 746.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 236.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .06
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 127.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1462.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .08
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 136.12

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 4701
ENERGY CONSERVATION OPPORTUNITY: ECO-7
SYSTEM MODIFICATION: INSTALL INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-7, install instrumentation to facilitate efficient operation of boiler plant.
It was estimated that the energy wasted from boiler in standby is 1% of the rated output capacity. The hours when boilers are running unnecessary were estimated for each boiler.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas (MMBtu)	Total Energy (MMBtu)
	Demand(kW)	Energy(kWh)		
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	0	0	61	61

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	61 MMBtu/Yr	X	$2.92 /MMBtu	=	$178 per year
Total Energy Cost Savings:	**$0**	+	**$178**	=	**$178 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $463 per year

Total: **$0** - **$463** = **($463) per year**

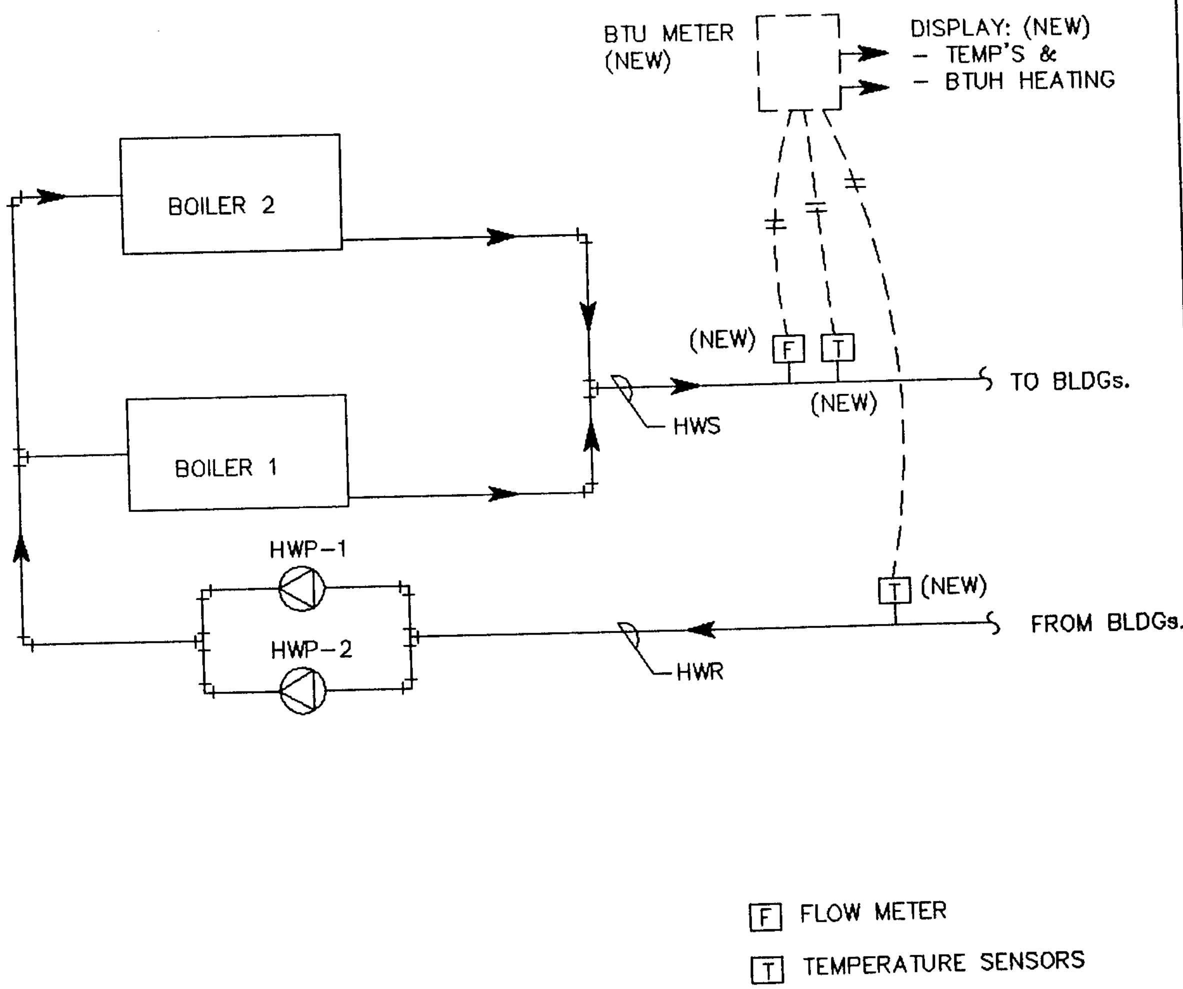
[ECO-SHT.WK3]

BOILER STANDBY SAVINGS

CENTRAL PLANT	BOILER NO.	BOILER TYPE	BOILER MANUFACTURERER	BOILER MODEL NUMBER	RATED BOILER OUTPUT MMBTU/H	CALC. BOILER OUTPUT MMBTU/H	STANDBY LOSS (1%) MMBTU/H	EXCESS STANDBY (HRS/YR)	EXCESS STANDBY MMBTU/H	EXCESS STANDBY SAVINGS ($)
5900	1	HTHW	INTERNATIONAL	D-12	10.00	6.94	0.0694	0		
	2	HTHW	INTERNATIONAL	D-12	10.00	7.17	0.0717	720	51.62	$150.74
	3	HTHW	HERCULES	300	9.70	7.61	0.0761	720	54.82	$160.09
	4	HTHW	HERCULES	300	9.70	7.58	0.0758	720	54.55	$159.27
	5	HTHW	INTERNATIONAL	1035 TH12	8.00	6.22	0.0622	0		
	6	HTHW	INTERNATIONAL	TJW-C-10	11.20	8.88	0.0888	0		
						TOTAL		2160	160.99	$470.10
6003	1	STEAM-12	KEWANEE	L39-350-605	11.72	9.41	0.0941	0		
	2	STEAM-12	YORK SHIPLEY	SPL-350-112080	11.72	9.12	0.0912	0		
	3	STEAM-12	KEWANEE	L36-350-605	11.72	9.37	0.0937	720	67.45	$196.96
						TOTAL		720	67.45	$196.96
730	1	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	0		
	2	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	720	44.34	$129.47
	3	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.18	0.0618	720	44.51	$129.96
	4	STEAM-12	KEWANEE	CAT#7L280-KG-06	2.66	2.11	0.0211	0		
						TOTAL		1440	88.84	$259.43
2812	1	STEAM-12	FEDERAL BOILER CO	GS 3562	1.80	1.40	0.0140	0		
	2	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.77	0.0277	0		
	3	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.86	0.0286	720	20.62	$60.21
						TOTAL		720	20.62	$60.21
5676	1	HW	AMERICAN STANDARD	PF 515	2.44	1.80	0.0180	720	12.93	$37.76
	2	HW	AMERICAN STANDARD	PF 515	2.44	1.71	0.0171	0		
						TOTAL		720	12.93	$37.76
5678	1	HW	BRUNHAM	PF 514	2.27	1.50	0.0150	720	10.79	$31.50
	2	HW	BRUNHAM	PF 514	2.27	1.63	0.0163	0		
						TOTAL		720	10.79	$31.50
914	1	STEAM-12	BRUNHAM	PF-510	1.61	1.29	0.0129	0		
	2	HW	RAY-PAK	EA 200ITB	1.61	1.22	0.0122	0		
	3	HW	AMERICAN STANDARD	G1015	1.92	1.47	0.0147	720	10.56	$30.84
	4	HW	AMERICAN STANDARD	G1015	1.92	1.40	0.0140	0		
						TOTAL		720	10.56	$30.84
4701	1	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	0		
	2	STEAM-100	BIRCHFIELD	FBH 578	11.00	0.00	0.0000	0		
	3	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	720	60.73	$177.33
						TOTAL		720	60.73	$177.33

[BOILERS.WK3]

ECO–7, INSTRUMENTATION FOR BOILER PLANT
(TYPICAL)



[B-ECO-7.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CODE A [X] CODE B [ ] CODE C

OTHER ______

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO BLDG. 4701	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
INSTRUMENTATION / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 3 STM BOILERS													
INSERT. FLOW METER W/TEMP & PRESSURE	1	EA			197	197			3480.00	3480.00	$3,677		
STM FLOW PROCESSOR	1	EA	6.0	6.0	20	118			695.00	695.00	$813		
LED DISPLAY	2	EA							60.00	120.00	$120		
LED INSTALLATION	2	EA	4.6	9.2	19.6	180			158	316	496.32		
SUBTOTAL						$495				$4,611	$5,106		
OVERHEAD, BOND	16%					$79				$738	$817		
PROFIT	10%					$49				$461	$511		
COST SUB-TOTAL						$624				$5,810	$6,433		
CONTINGENCY	20%					$125				$1,162	$1,287		
SUBTOTAL						$748				$6,972	$7,720		
S&A	5.5%					$41				$383	$425		
TOTAL THIS SHEET						$789				$7,355	$8,145		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: B4701EC1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER INSTRUMENTATION
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	7720.
B. SIOH	$	425.
C. DESIGN COST	$	464.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	7748.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	7748.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	61.	$ 177.	12.48	2213.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		61.	$ 177.		$ 2213.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -463.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -4218.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -4218.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 730.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -286.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -2005.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.26
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -27.12

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 4701
ENERGY CONSERVATION OPPORTUNITY: ECO- 10
SYSTEM MODIFICATION: OXYGEN TRIM FOR BURNERS
SYSTEMS TO MODIFY: BOILER 1, 2, AND 3

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-10, install oxygen trim for burners.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	9,596	9,596
ECO	--	--	9,436	9,436
Savings (Baseline-ECO)	0	0	160	160

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	160 MMBtu/Yr	X	$2.92 /MMBtu	=	$467 per year
Total Energy Cost Savings:	**$0**	**+**	**$467**	**=**	**$467 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand:	0 kW/month	X	$1.787 /kW	X	12 months/year
	=	(+)	$0 per year		
Maintenance:	=	(-)	$1,799 per year		
Total:	**$0**	**-**	**$1,799**	**=**	**($1,799) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 4701 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	7875.
PEAK DAY GAS CONSUMP., 1000 CU FT	99.
ELECTRICAL CONSUMPTION, KWH	305028.
PEAK KW DEMAND (15 MIN BASIS)	396.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	305028.
ON-PEAK KW DEMAND (15 MIN BASIS)	396.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
CHILLER 2	1873
BOILER OPERATING HOURS	
BOILER 1	1205
BOILER 2	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

CENTRAL PLANT 4701 BASELINE-2

SYSTEM C1 SUMMER HW LOADS

** TOTAL **

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	1720.
PEAK DAY GAS CONSUMP., 1000 CU FT	16.
ELECTRICAL CONSUMPTION, KWH	0.
PEAK KW DEMAND (15 MIN BASIS)	0.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	0.
ON-PEAK KW DEMAND (15 MIN BASIS)	0.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
BOILER OPERATING HOURS	
BOILER 1	647
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 4701 BOILER ECO-4

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	7733.
PEAK DAY GAS CONSUMP., 1000 CU FT	97.
ELECTRICAL CONSUMPTION, KWH	305028.
PEAK KW DEMAND (15 MIN BASIS)	396.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	305028.
ON-PEAK KW DEMAND (15 MIN BASIS)	396.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
CHILLER 2	1873
BOILER OPERATING HOURS	
BOILER 1	1205
BOILER 2	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 4701 BOILER ECO-4

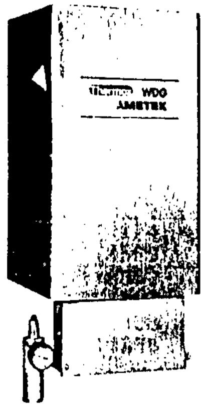
** TOTAL **

SYSTEM C1 SUMMER HW LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	1703.
PEAK DAY GAS CONSUMP., 1000 CU FT	16.
ELECTRICAL CONSUMPTION, KWH	0.
PEAK KW DEMAND (15 MIN BASIS)	0.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	0.
ON-PEAK KW DEMAND (15 MIN BASIS)	0.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
BOILER OPERATING HOURS	
BOILER 1	642
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

SPECIFICATIONS – AIR-MIZER II SYSTEM

SENSOR



Nominal Dimensions: 14⅝"H x 10¼"W x 10"D (37.2 x 26 x 25.4 cm)

Enclosure: Weather resistant—S.S. case, nickel plated carbon steel base

Weight: 55 pounds (25 kg)

Accuracy: ±1% of net excess oxygen

Repeatability: ±0.2% of measured value

Response: 90% of full scale in less than 5 seconds

Drift: Less than 0.1% of sensor cell output per month

Ambient Temperatures: –5 to +175°F (–20.5 to +79°C)

Sample Temperatures: Up to 1300°F (704°C) with standard probe

Sample Flow Rate: 0.1 to 120 scfh (0.47 to 56.65 liters/minute)

Air Aspirator Requirements: 10 to 20 scfh (4.72 to 14.16 liters/ min) at 15-100 psi (1.05 to 7.037 kg/cm^2) (Aspirator air regulator furnished with sensor normally set at 2-7 psi; 0.14 - 0.49 kg/cm^2)

Calibration: With analyzed oxygen in nitrogen sample. Calibration port provided.

CONTROL UNIT

Nominal Dimensions: 12⅝"H x 10⅞"W x 9⅛"D (32.1 x 27.6 x 23.2 cm)

Enclosure: Wall/panel mounted—meets the requirements for NEMA 4 areas

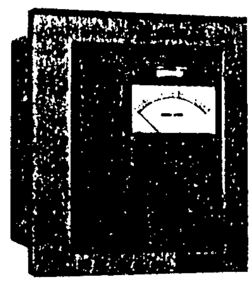
Weight: 22 pounds (10 kg)

Temperature Control: On-Off by microprocessor (±1°C)

Linearization: 256 segments from 20% to 0.2% O_2, (218 from 10% to 0.2%), by microprocessor

Controller Action: On-Off—"On" time adjustable 2-20 seconds. "Off" time adjustable 2-60 seconds.
Deadband: ± 0.25% oxygen.
LED's indicate motor driving.
Will not allow decrease in air when O_2 is below 0.5% oxygen. Air flow will increase to +15% max. If O_2 level is above 12%.

Setpoint: 0 to 10% oxygen by either of: A. Two banks of 5 slide pots, (Dual Fuel) selectable by slide switch; proper pot or pots connected to processor by switch in actuator. B. Manual pot on panel A or B selected by Remote/Local switch on panel. Setpoint indicated by edge reading meter (0-10%)



Manual Control: Manual/Auto switch and increase—decrease push buttons (Spring return switch inside control unit can override all control actions in the event of processor failure).

Ready Indicator: On at temperature set point. Off below temperature set point. Flashes above temperature set point. O_2 Control in "manual" when below set point.

Oxygen Scale: 20.9 to 0.1% O_2 Logarithmic

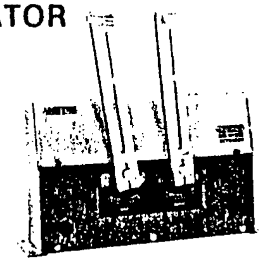
Alarms: High and Low O_2 adjustable 0.2 to 20%. RTD Failure (shuts down temperature control, and puts O_2 control in "manual").

Increase Air Override: Contact closure from optional combustibles or smoke detector alarm will cause increase in air signal on each control pulse regardless or O_2 vs. O_2 setpoint relationship. Once combustibles contact opens, normal control will resume. This maintains air flow at a level where maximum allowable combustibles or smoke is not exceeded.

Ambient Temperature Limits: 32°F to 140°F (0 to +60°C)

Recorder Output: 0-100 mv = 0-20% O_2 Linear (0-50 mv = 0-10%) Other current or voltages outputs optional

ACTUATOR



Overall Size: 17½"L x 4"W x 10¼"H (44.5 x 10.2 x 26 cm)

Weight: 16.5 pounds (7.5 kg)

Angular Travel (Input Arm): 60°

Linear Link Travel: Adjustable 4" to 10" at 4" to 10" Radius (10.2 to 25.4 cm at 10.2 to 25.4 cm Radius)

Linear Link Force: 100 pounds at 4" Radius (45.5 kg at 10.2 cm Radius)
70 pounds at 6" Radius (31.8 kg at 15.2 cm Radius)
40 pounds at 10" Radius (18.2 kg at 25.4 cm Radius)

Case: Suitable for areas requiring NEMA 2 equipment (Drip proof indoor)

Correction: –15% to +15% (.85 to 1.15 gain) of normal air flow

Speed: 60 seconds from –15% to +15% correction (max.)

Load Indication: 9 position shorting switch tied to input arm

Brake: Internal brake will hold load at any above rated force without "coasting"

Ambient Temperature Limits: 0°F to 160°F (–18 to +71°C)

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.	DACA 59-90-C-0087
CODE A [X] CODE B [ ] CODE C [ ] OTHER ______	
EFFECTIVE PRICING DATE	APR. 91
DATE PREPARED	08-Apr-91
DRAWING NO.	
SHT	OF
ESTIMATOR	KC
CHECKED BY	CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

BOILER ECO BLDG. 4701

BOILER CONTROL O2 TRIM

TASK DESCRIPTION	Quantity No. Of Units	Quantity Unit Meas	LABOR MH/ Unit	LABOR Total Hrs	LABOR Unit Price	LABOR Cost	EQUIPMENT Unit Price	EQUIPMENT Cost	MATERIAL Unit Price	MATERIAL Cost	TOTAL	SHIPPING Unit Wt	SHIPPING Total Wt
O2 TRIM CONTROL	2	EA			3000	$6,000			$1,800	$9,590	$15,590		
ANNUAL RECURRING COST													
OXYGEN SENSOR	2	EA	0.5	1.0	24	$24			$420	$840	$864		
OTHER MAINTENANCE COST	1	LS							$935	$935	$935		
ANNUAL TOTAL											$1,799		
SUBTOTAL						$6,000				$9,590	$15,590		
OVERHEAD, BOND	16.0%					$960				$1,534	$2,494		
PROFIT	10.0%					$600				$959	$1,559		
COST SUB-TOTAL						$7,560				$12,083	$19,643		
CONTINGENCY	20.0%					$1,512				$2,417	$3,929		
SUBTOTAL						$9,072				$14,500	$23,572		
S&A	5.5%					$499				$798	$1,296		
TOTAL THIS SHEET						$9,571				$15,298	$24,869		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 4701EC10
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER O2 TRIM CONTROL
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	23572.
B. SIOH	$	1297.
C. DESIGN COST	$	1415.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	23656.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	23656.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	160.	$ 467.	12.48	5831.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		160.	$ 467.		$ 5831.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1799.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -16389.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -16389.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1924.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -1332.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -10558.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.45
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -17.76

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 4701
ENERGY CONSERVATION OPPORTUNITY: ECO- 12
SYSTEM MODIFICATION: STACK ECONOMIZERS
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-12, install stack economizer for boilers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	9,596	9,596
ECO	--	--	9,507	9,507
Savings (Baseline-ECO)	0	0	89	89

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	89 MMBtu/Yr	X	$2.92 /MMBtu	=	$260 per year
Total Energy Cost Savings:	**$0** +		**$260**	=	**$260 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand:		0 kW/month	X	$1.787 /kW	X	12 months/year
	=	(+)	$0 per year			
Maintenance:	=	(-)	$0 per year			
Total:	**$0**	-	**$0**	=	**$0 per year**	

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 4701 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	7875.
PEAK DAY GAS CONSUMP., 1000 CU FT	99.
ELECTRICAL CONSUMPTION, KWH	305028.
PEAK KW DEMAND (15 MIN BASIS)	396.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	305028.
ON-PEAK KW DEMAND (15 MIN BASIS)	396.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
CHILLER 2	1873
BOILER OPERATING HOURS	
BOILER 1	1205
BOILER 2	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 4701 BASELINE-2

** TOTAL **

SYSTEM C1 SUMMER HW LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	1720.
PEAK DAY GAS CONSUMP., 1000 CU FT	16.
ELECTRICAL CONSUMPTION, KWH	0.
PEAK KW DEMAND (15 MIN BASIS)	0.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	0.
ON-PEAK KW DEMAND (15 MIN BASIS)	0.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
BOILER OPERATING HOURS	
BOILER 1	647
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 4701 BOILER ECO-6

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	7800.
PEAK DAY GAS CONSUMP., 1000 CU FT	98.
ELECTRICAL CONSUMPTION, KWH	305028.
PEAK KW DEMAND (15 MIN BASIS)	396.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	305028.
ON-PEAK KW DEMAND (15 MIN BASIS)	396.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	1873
CHILLER 2	1873
BOILER OPERATING HOURS	
BOILER 1	1205
BOILER 2	0
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

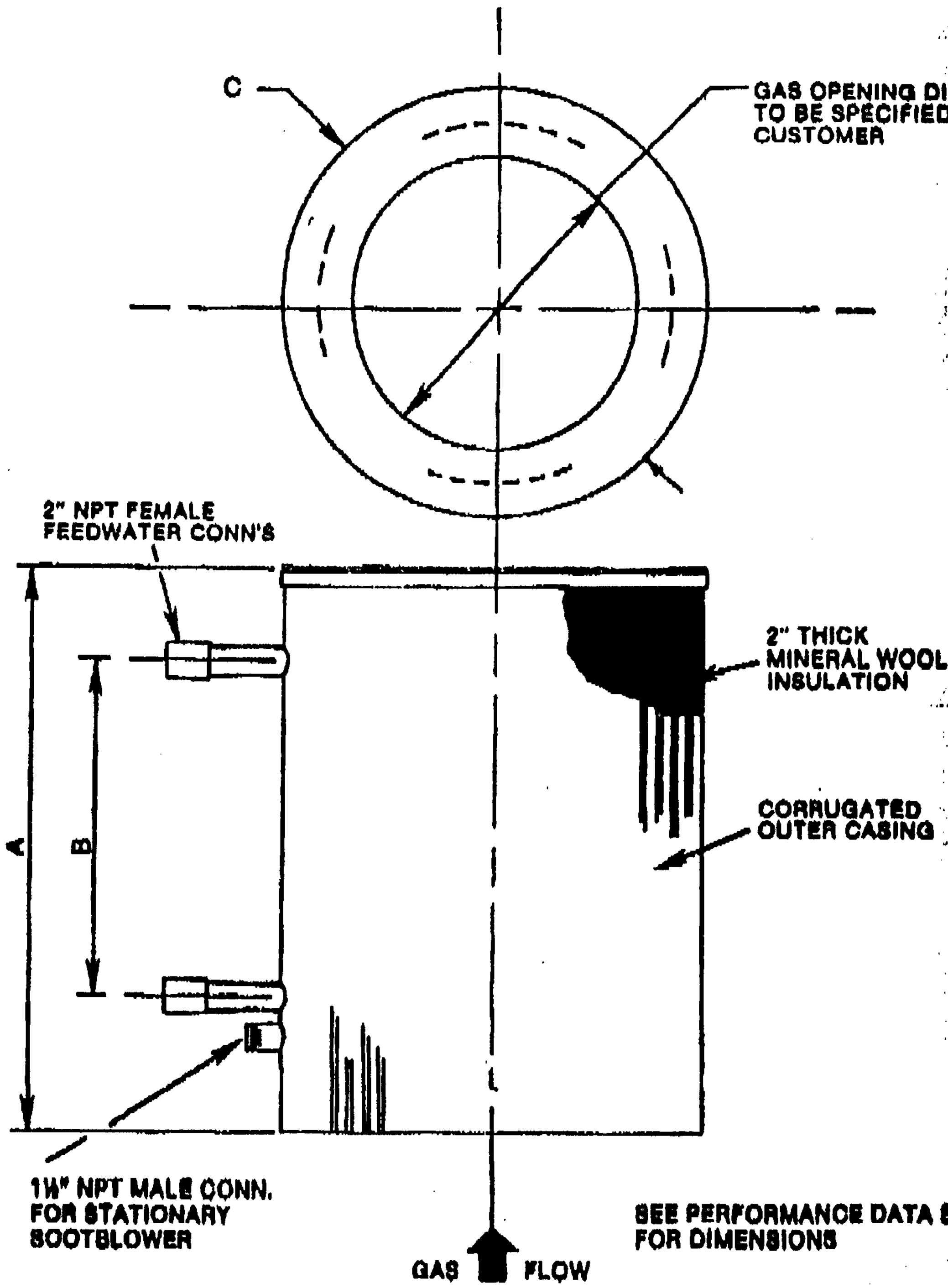
CENTRAL PLANT 4701 BOILER ECO-6

** TOTAL **

SYSTEM C1 SUMMER HW LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	1708.
PEAK DAY GAS CONSUMP., 1000 CU FT	16.
ELECTRICAL CONSUMPTION, KWH	0.
PEAK KW DEMAND (15 MIN BASIS)	0.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	0.
ON-PEAK KW DEMAND (15 MIN BASIS)	0.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
BOILER OPERATING HOURS	
BOILER 1	643
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Kentube Cylindrical Fuel Economizer



SEE PERFORMANCE DATA SHEET FOR DIMENSIONS

Kentube
4150 South Elwood • Tulsa, Oklahoma 47107
918/446-4581 • Telex: 49-7353

***** ****

CUSTOMER
EMC Engineers
PROPOSAL 318-10351-0-0
RUN 00

KENTUBE
4150 S. ELWOOD
TULSA, OKLAHOMA

PRINTED 04/10/91
TIME 09 HRS 10 MINS
CUST. REFERENCE

CYLINDRICAL FUEL ECONOMIZER MODEL 100930

OVERALL PERFORMANCE

COUNTER CURRENT FLOW
FLUID CIRCULATED IN TUBES IS WATER

HEAT EXCHANGED	97907.	BTU/HR
U EXTERNAL	4.811	BTU/HR-SQFT-F
LMTD	150.1	DEG F

OVERALL CONSTRUCTION

VERTICAL GAS FLOW
DIMENSIONS

DIM A	(HEIGHT)	5'-3/4"
DIM B	(NOZ C-C)	3'-3 3/8"
DIM C	(DIAMETER)	2'-1 1/2"
DRAWING NO		V- 1

SOOT BLOWERS ARE BUILT IN

NOZZLE SIZE	2.0	IN
SURFACE AREA	136.	SQFT
LIQUID WEIGHT	70.	LB
UNIT WEIGHT(DRY)	742.	LB

PERFORMANCE SPECIFICATIONS

	TUBE SIDE ↓	GAS SIDE ↑	
FLOW RATE	2070.	2474.	LB/HR
TEMP IN	180.0	450.0	DEG F
TEMP OUT	227.2	301.1	DEG F
PRES IN	150.0 PSIG	14.7	PSIA
PRES DROP	.0 PSI	.19	IN WATER

CONSTRUCTION SPECIFICATIONS
TUBE SIDE

DESIGN PRESSURE		490.	PSI
TEST PRESSURE		735.	PSI
DESIGN TEMPERATURE		700.	DEG
TUBE	OUTSIDE DIA	2.000	IN
	MATERIAL	C/STL	
FIN	THICKNESS	.060	IN
	PITCH	3.00	FINS/
	MATERIAL	C/STL	
INSULATION			
	MATERIAL	MINERAL WOOL	
	THICKNESS	2.0	IN

Kentube DIVISION FABRICATED PRODUCTS

4150 S. Elwood
Tulsa, Oklahoma 74107
Phone: (918) 446-4561
FAX: (918) 446-6340

QUOTATION

TO	EMC Engineers 2750 South Wadsworth Blvd. Denver, CO 80227 Attention: Mr. Dennis Jones

QUOTATION DATE	YOUR REFERENCE	OUR REFERENCE
04/10/91		318-10351-0-0

SHIPPING ESTIMATE	TERMS	PAGE
8 Weeks*	Net 30 Days	PAGE 1 OF 3

SHIPPING DESTINATION	F.O.B.
	Kentube Shop**

THANK YOU FOR YOUR INQUIRY. WE APPRECIATE THE OPPORTUNITY TO PROPOSE THE FOLLOWING:

ITEM	QUANTITY	DESCRIPTION	UNIT AMOUNT	AMOUNT
	4	Kentube RETROMISER Fuel Economizer Cylindrical Model 100930, in accordance with the attached performance specifications. **DESIGN FEATURES** Finned tube unit; 3 Fins per inch; Vertical gas flow; Counter-current flow Fuel type: NATURAL GAS. Estimated Shipping Weight - 742. LBS. Pressure parts to Section I of the ASME Boiler & Pressure Vessel Code. External 2" insulation with weatherproof, corrugated casing is included. Threaded drain and vent connections included. Kentube manually operated sootblower, integral with unit, included. Requires 85 psig to 250 psig supply pressure.	$ 3011.	$ 12044.

ENCLOSURES
cc: Ted D. Miller Associates

NOTE: All shipping estimates are based on "after receipt of order" and "after final print approvals" as required. Shipments can often be improved upon request. Please contact Kentube.
Prices firm for 30 days and subject to change thereafter. No provision is made for Federal, State or Municipal taxes. All orders are subject to acceptance or rejection by the Credit Department of Kentube and to the Terms of Sale attached.

YOUR REPRESENTATIVE IS:	YOUR ORDER WILL RECEIVE OUR PROMPT ATTENTION
Ted D. Miller Associates 2140 South Ivanhoe Denver, CO 80222	KENTUBE FABRICATED PRODUCTS Larry Wolfe Larry Wolfenbarger Product Sales Engineer

Kentube

FABRICATED PRODUCTS

QUOTATION

TO	ENC Engineers	/318-10351-0-0

ITEM	QUANTITY	DESCRIPTION	UNIT AMOUNT	AMOUNT
		SUGGESTED ACCESSORIES (Quantities below are for each unit)		
	1	Bolted access manway in casing, approximately 16" Square, carbon steel construction.	$ 300.	$ 300.
	1	1/2" Threaded connection for safety relief valve on header.	$ 100.	$ 100.
	1	1/2" Threaded safety relief valve, Kunkle series 927.	$ 555.	$ 555.
		** All prepaid and bill shipments will be at the billable freight amount plus a service charge of 10%. A service charge is not required for collect shipments or third party billing.		
		* KENTUBE is a member of the * * AMERICAN BOILER MANUFACTURERS ASSOCIATION *		

COST ESTIMATE ANALYSIS

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER LOCATION FT. SILL, OKLAHOMA	INVITATION NO./CONTRACT NO. DACA 59-90-C-0087 [ ] CODE A [X] CODE B [ ] CODE C [ ] OTHER ______	EFFECTIVE PRICING DATE APR. 91 DRAWING NO. ESTIMATOR KC	DATE PREPARED 11-Apr-91 SHT OF CHECKED BY CEL

STACK ECONOMIZER ECO-11 BLDG. 4701 TASK DESCRIPTION	Quantity No. Of Units	Quantity Unit Meas	LABOR MH/ Unit	LABOR Total Hrs	LABOR Unit Price	LABOR Cost	EQUIPMENT Unit Price	EQUIPMENT Cost	MATERIAL Unit Price	MATERIAL Cost	TOTAL	SHIPPING Unit Wt	SHIPPING Total Wt
STACK ECONOMIZER & ACC.	2	EA	366.7	733.3	24	17600			5869.00	11738.00	$29,338	1768	3536
SUBTOTAL						$17,600				$11,738	$29,338		
OVERHEAD, BOND	16%					$2,816				$1,878	$4,694		
PROFIT	10%					$1,760				$1,174	$2,934		
COST SUB-TOTAL						$22,176				$14,790	$36,966		
CONTINGENCY	20%					$4,435				$2,958	$7,393		
SUBTOTAL						$26,611				$17,748	$44,359		
S&A	5.5%					$1,464				$976	$2,440		
TOTA[illegible]IS SHEET						$28,075				$18,724	$46,799		

DA FORM[illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: 4701EC11
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA — REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ECONOMIZER AIR PREHEAT
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	44359.
B. SIOH	$	2440.
C. DESIGN COST	$	2662.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	44515.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	44515.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	77.	$ 225.	17.52	3939.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		77.	$ 225.		$ 3939.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1300.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 225.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 3939.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .09
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 197.98

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 4701
ENERGY CONSERVATION OPPORTUNITY: ECO-14
SYSTEM MODIFICATION: NEW CHW & CW PUMPS TO MATCH LOAD
SYSTEMS TO MODIFY: NEW CHW & CW PUMPS

CALCULATION DESCRIPTION:
Hand calculation sheet was prepared to determine the energy savings for ECO-14, install new pump to match load requirements.
It was estimated that the electrical energy can be saved by installing smaller pumps to match the load, based on the pump operating hours per year.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	0	0
ECO	--	--	0	0
Savings (Baseline-ECO)	0	50,401	0	172

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	172 MMBtu/Yr	X	$4.0141 /MMBtu	=	$690 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$690**	+	**$0**	=	**$690 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $0 per year

Total: **$0** - **$0** = **$0 per year**

[ECO-SHT.WK3]

E M C ENGINEERS, INC.
Denver • Colorado Springs • Atlanta • West Germany

JOB: Ft. SILL CENTRAL PLANT 3002.000
SHEET NO. 1 OF 1
CALCULATED BY: KC DATE: 4-3-91
CHECKED BY: CEL DATE: 4-18-91
SCALE: CHILLER ECO-14

ADDITIONAL PUMPS FOR CHW & CNW SYSTEM BLDG. 4701

CHILLED WATER: FLOW $= \frac{TONS \times 12000}{\Delta T \times 500} = \frac{305 \times 12000}{(53-43) \times 500} = 732$ GPM @ 100 TDH-Ft

$BHP = \frac{TDH\text{-}Ft \times GPM}{3960 \times 0.8} = \frac{100 \times 732}{3960 \times 0.8} = 23.11$ BHP

$MOTOR\ HP = \frac{BHP}{\%\ EFF(PUMP)} = \frac{23.11}{80\%} = 28.88$ HP

$KW = \frac{HP \times 0.746}{\%\ EFF(MOTOR)} = \frac{28.9 \times 0.746}{92\%} = 23.42$ KW

CONDENSING WATER:

FLOW = 825 GPM @ 52 TDH-Ft (DESIGN DWG.)

$BHP = \frac{TDH\text{-}Ft \times GPM}{3960 \times 0.8} = \frac{52 \times 825}{3960 \times 0.8} = 13.54$ BHP

$MOTOR\ HP = \frac{BHP}{\%\ EFF(PUMP)} = \frac{13.54}{80\%} = 16.92$ HP

$KW = \frac{HP \times 0.746}{\%\ EFF(MOTOR)} = \frac{16.92 \times 0.746}{91.7\%} = 13.77$ KW

PEAK COOLING LOAD IS 6.6 MMBtuh

275 TONS CHILLER CAN SUPPLY = 275 X 12000 = 3.3 MMBtuh

∴ PERCENT OF LOAD IS $= \frac{3.3\ MMBtuh}{6.6\ MMBtuh} = 50\%$

FROM PC-CUBE BASERUN HRS @ 50% IS 1786 HRS/YR

EXISTING ENERGY USAGE: 50 HP @ 92.73% EFF
30 HP @ 88.87% EFF

$KW = \frac{50 HP \times 0.746\ KW/HP}{92.73\%} + \frac{30 HP \times 0.746\ KW/HP}{88.87\%} = 65.41$ KW

NEW ENERGY USAGE:

KW SAVINGS = 65.41 − 23.42 − 13.77 = 28.22 KW

$ SAVINGS = 28.22 KW X 1786 HR X 0.0137 $/KWH

= $690./YR

OR = ~~KWH~~ OR ~~6.07~~ MMBtu
50,401 KWH/YR 172 MMBtu/YR

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ________

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 15-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

PUMP ECO-14 BLDG. 4701 / NEW PUMP TO MATCH LOAD	QUANTITY		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CHW PUMP 732 GPM	1	EA	7.0	7.0	24	168			800.00	800.00	$968		
PUMP PAD	1	EA							24.00	24.00	$24		
PUMP PIPING CONNECTION	1	EA							450.00	450.00	$450		
PIPING CONNECTION MATERIALS	1	EA	24	24.0	24	576			3000.00	3000.00	$3,576		
30 HP MOTOR INSTALLATION	1	EA	34.8	34.8	24	835			860.00	860.00	$1,695		
MOTOR SETTING	1	EA	3.3	3.3	24	80					$80		
CNW PUMP 825 GPM	1	EA	7.0	7.0	24	168			850.00	850.00	$1,018		
PUMP PAD	1	EA							24.00	24.00	$24		
PUMP PIPING CONNECTION	1	EA							450.00	450.00	$450		
PIPING CONNECTION MATERIALS	1	EA	24	24.0	24	576			3000.00	3000.00	$3,576		
20 HP MOTOR INSTALLATION	1	EA	30.6	30.6	24	735			600.00	600.00	$1,335		
MOTOR SETTING	1	EA	3.1	3.1	24	74					$74		
SUBTOTAL						$3,212				$10,058	$13,270		
OVERHEAD, BOND	16.0%					$514				$1,609	$2,123		
PROFIT	10.0%					$321				$1,006	$1,327		
COST SUB-TOTAL						$4,047				$12,673	$16,720		
CONTINGENCY	20.0%					$809				$2,535	$3,344		
SUBTOTAL						$4,856				$15,208	$20,064		
S&A	5.5%					$267				$836	$1,104		
TOTAL THIS SHEET						$5,123				$16,044	$21,168		

DA FORM APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 4701EC14
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: PUMP TO MATCH LOAD
ANALYSIS DATE: 04-15-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	20064.
B. SIOH	$	1104.
C. DESIGN COST	$	1204.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	20135.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	20135.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	172.	$ 690.	11.37	7850.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		172.	$ 690.		$ 7850.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 2591.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 690.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 7850.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .39
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 29.16

CENTRAL PLANT 5676

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5676
ENERGY CONSERVATION OPPORTUNITY: ECO-3
SYSTEM MODIFICATIOIN: CHILLER REPLACEMENT
SYSTEMS TO MODIFY: CHILLER 1

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-3, renovate or replace existing chillers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	165	299,000	--	1,020
ECO	69	162,000	--	553
Savings (Baseline-ECO)	96	137,000	0	468

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 468 MMBtu/Yr X $4.0141 /MMBtu = $1,877 per year

Nat. Gas: 0 MMBtu/Yr X $2.92 /MMBtu = $0 per year

Total Energy Cost Savings: $1,877 + $0 = $1,877 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 96 kW/month X $1.787 /kW X 12 months/year

= (+) $2,059 per year

Maintenance: = (-) $3,000 per year

Total: $2,059 - $3,000 = ($941) per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	13463.
PEAK DAY GAS CONSUMP., 1000 CU FT	137.
ELECTRICAL CONSUMPTION, KWH	298696.
PEAK KW DEMAND (15 MIN BASIS)	165.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	298696.
ON-PEAK KW DEMAND (15 MIN BASIS)	165.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2057
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 CHILLER ECO-3

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING W/CHILLER IMPROVEMENT 90% EFF

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	13463.
PEAK DAY GAS CONSUMP., 1000 CU FT	137.
ELECTRICAL CONSUMPTION, KWH	160907.
PEAK KW DEMAND (15 MIN BASIS)	69.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	160907.
ON-PEAK KW DEMAND (15 MIN BASIS)	69.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2057
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 09-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO-3 BLDG. 5676	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
HIGH EFFICIENCY CHILLERS / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CHILLER REPLACEMENT													
170 TON CHILLER	1	EA	56.0	56.0	24	1344	550	550	56371.00	56371.00	$58,265		
REMOVE EXISTING CHILLER	1	LS	36.0	36.0	24	864					$864		
SUBTOTAL						$2,208		$550		$56,371	$59,129		
OVERHEAD, BOND	16%					$353		$88		$9,019	$9,461		
PROFIT	10%					$221		$55		$5,637	$5,913		
COST SUB-TOTAL						$2,782		$693		$71,027	$74,503		
CONTINGENCY	20%					$556		$139		$14,205	$14,901		
SUBTOTAL						$3,338		$832		$85,233	$89,403		
S&A	5.5%					$184		$46		$4,688	$4,917		
TOTA[illegible]S SHEET						$3,522		$877		$89,921	$94,320		

DA FORM [illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C5676EC3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER REPLACEMENT
ANALYSIS DATE: 04-09-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	89403.
B. SIOH	$	4918.
C. DESIGN COST	$	5365.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	89717.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	89717.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	468.	$ 1877.	11.37	21340.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		468.	$ 1877.		$ 21340.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -941.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -10963.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -10963.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 7042.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 936.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 10378.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .12
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 95.86

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5676
ENERGY CONSERVATION OPPORTUNITY: ECO-4
SYSTEM MODIFICATION: INSTALL ICE STORAGE COOLING SYSTEM
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Hand calculation sheet was prepared to determine the energy savings for ECO-4, install ice storage system for HVAC cooling.
It was estimated that the peak electrical demand can be saved by installing ice storage cooling system.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	250	0	0	0

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 0 MMBtu/Yr X $4.0141 /MMBtu = $0 per year

Nat. Gas: 0 MMBtu/Yr X $2.92 /MMBtu = $0 per year

Total Energy Cost Savings: $0 + $0 = $0 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 250 kW/month X $1.787 /kW X 12 months/year

= (+) $5,361 per year

Maintenance: = (-) $0 per year

Total: $5,361 - $0 = $5,361 per year

[ECO-SHT.WK3]

A new application of an old idea that can cut air conditioning energy costs in half.

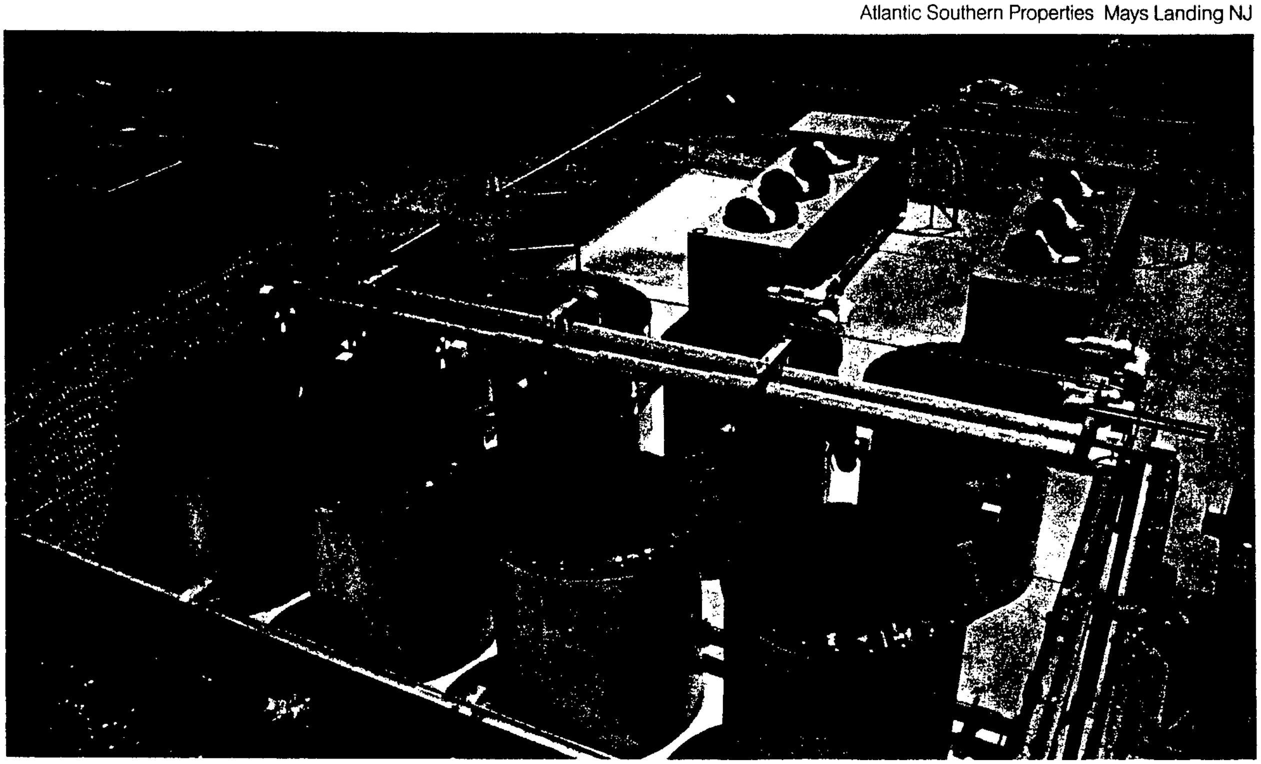
Air conditioning during summer daytime hours is the largest single contributor to utility "peak demand" charges. After noon, as more air conditioners are needed to maintain comfortable temperatures, the increased demand for electricity adds to that already created by lighting, operating equipment, computers and thousands of other uses. This requires the utility to bring additional, more costly generating sources on line to handle its increased demand. Commercial users whose large air conditioning loads contribute to these added generating requirements are assessed an additional charge based on their highest on-peak demand for electricity.

An Ice Bank Stored Cooling System is either a load-shifting or load-leveling method which will significantly lower demand charges during the air conditioning season and, consequently, energy costs. It uses a standard packaged chiller to produce solid ice at night during off-peak periods when the building's electrical needs are at a minimum. The ice is built and stored in modular ice tanks to provide cooling to help meet the building's air conditioning load requirement the following day.

Making ice at night and using its stored energy during the day is not a new or experimental idea. This concept had been employed for years in cooling short-peak applications such as churches and theatres. However, longer peak uses were served by air-source rooftop and chiller-type air conditioners which were less costly to install. Now there is renewed interest in a broad use of ice-making systems by both users and utilities as the best way to offset rising operating costs. In fact, Stored Cooling Systems are what summer-peaking utilities *must have* to avoid the unbearable costs of new generating plants.

Ice Banks not only can cut operating costs in half but they can also substantially reduce capital outlays when systems are suitably designed for new commercial and industrial buildings. Engineers can specify half-size chillers operating 24 hours a day rather than full-size chillers operating only 10 or 12 hours per day. In retrofit applications, an Ice Bank Stored Cooling System can often provide cooling for an addition to a building without adding chiller capacity.

Atlantic Southern Properties Mays Landing NJ



How the LEVLOAD System Works

The LEVLOAD Ice Bank is a modular, insulated polyethylene tank containing a spiral-wound plastic tube heat exchanger surrounded with water. They are available in four sizes – 90, 100, 190 and 570 ton-hours. At night, a 75 percent water - 25 percent glycol solution from a standard packaged air conditioning chiller circulates through the heat exchanger and extracts heat until eventually all the water in the tank is frozen solid. The ice is built uniformly throughout the tank by the patented temperature-averaging effect of closely spaced counterflow heat exchanger tubes, Figure 5. Water does not become surrounded by ice during the freezing process and can move freely as ice forms, preventing stress or damage to the tank.

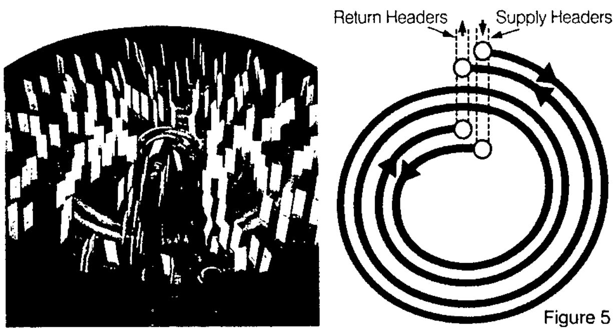


Figure 5

Typical flow diagrams for a Partial Storage System are shown in Figures 6 and 7.

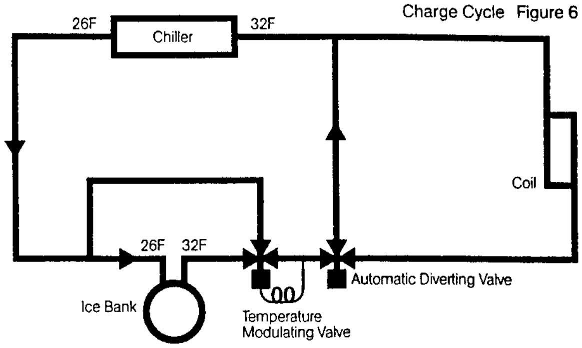
At night, the water-glycol solution circulates through the chiller and the Ice Bank heat exchanger, bypassing the air handler coil. The fluid is at 26F and freezes the water surrounding the heat exchanger.

During the day, the solution is cooled by the Ice Bank from 52F to 34F. A temperature modulating valve set at 44F in a bypass loop around the Ice Bank permits a sufficient quantity of 52F fluid to bypass the Ice Bank, mix with the 34F fluid, and achieve the desired 44F temperature. The 44F fluid enters the coil, where it cools air from 75F to 55F. The fluid leaves the coil at 60F, enters the chiller and is cooled to 52F.

It should be noted that, while making ice at night, the chiller must cool the water-glycol solution to 26F, rather than produce 44 or 45F water temperatures required for conventional air conditioning systems. This has the effect of "derating" the nominal chiller capacity by approximately 30 percent. Compressor efficiency, however, is only slightly reduced because lower nighttime temperatures result in cooler condenser water from the cooling tower and help keep the unit operating efficiently. Similarly, air cooled chillers benefit from cooler condenser entering air temperatures at night.

The temperature modulating valve in the bypass loop has the added advantage of providing unlimited capacity control. During many mild temperature days in the spring and fall, the chiller will be capable of providing all the necessary cooling for the building without assistance from stored cooling. When the building's actual cooling load is equal to or lower than the chiller capacity, all of the system coolant flows through the bypass loop, as in Figure 8.

Charge Cycle Figure 6



Discharge Cycle Figure 7

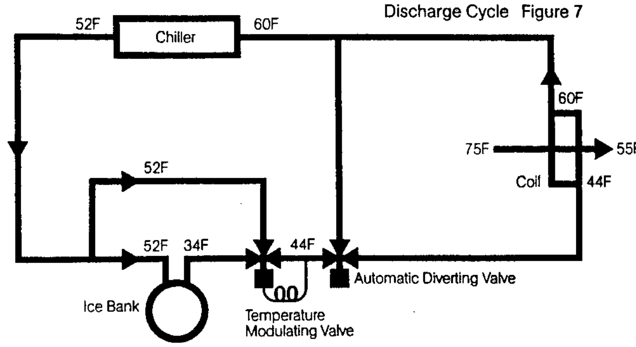
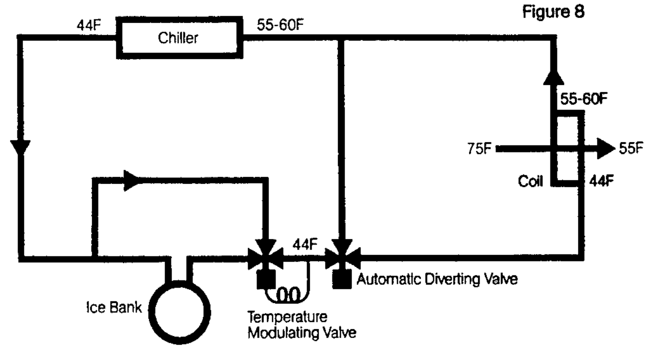


Figure 8



The glycol recommended for the solution is an ethylene glycol-based industrial coolant, such as Dow Chemical Company's Dowtherm® SR-1 or Union Carbide Corporation's UCARTHERM,® which are specially formulated for low viscosity and superior heat transfer properties. These contain a multi-component corrosion inhibitor system which is effective with most materials of construction, including aluminum, copper, solder and plastics. Unlike automotive-type anti-freeze, they produce no films and contain no anti-leak agents to interfere with heat transfer efficiency and permit use of standard system pumps, seals and air handler coils. However, because of the slight difference in heat transfer coefficient between water-glycol and plain water, coil capacity should be increased by approximately 5 percent. It is also important that the water and glycol be thoroughly mixed before the solution enters the system.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: 5676EC4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA   REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000   ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991   DISCRETE PORTION NAME: ICE STORAGE COOLING SYSTEM
ANALYSIS DATE: 04-18-91   ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	40800.
B. SIOH	$	2244.
C. DESIGN COST	$	2448.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	40943.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	40943.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) — $ 5361.
(1) DISCOUNT FACTOR (TABLE A) — 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) — $ 62456.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 62456.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 0.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 5361.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 62456.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.53
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 7.64

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5676
ENERGY CONSERVATION OPPORTUNITY: ECO-5(A)
SYSTEM MODIFICATION: TWO SPEED FANS FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO-5, install two-speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	6,497	--	22
ECO	--	2,397	--	8
Savings (Baseline-ECO)	0	4,100	0	14

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	14 MMBtu/Yr	X	$4.0141 /MMBtu	=	$56 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$56**	+	**$0**	=	**$56 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $0 per year

Total: **$0** - **$0** = **$0 per year**

[ECO-SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input (part 7). The control sequence is:

- 0-50% load, fan 1, half speed cycling.
- 50-100% load, fan 1 full speed cycling.

kWh per bin, for % design loads less than 50% load = (fan 1 power kW) * 14% * (%design load / 50) * 4 hours per bin * days per month.

kWh per bin, for % design loads 50% to 100% load = (fan 1 power kW * ((% design load)/ 100) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 5676	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	77
– WATER FLOW (gpm)	525
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	2178.75
HEAT REJECTION CAPACITY (Btu/min)	43575
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	40.57
TOTAL ENTHALPY	60.57
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	32899
MOTOR DATA	
– FAN 1 POWER (kW)	5.6
– FAN 2 POWER (kW)	0
– FAN 3 POWER (kW)	0
– FAN 4 POWER (kW)	0

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET–BULB AVERAGES (4 hour bins)						DESIGN
	1–4	5–8	9–12	13–16	17–20	21–24	WB
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	77
MAY	57.1	56.6	61.2	63.9	63	59.4	77
JUNE	66.8	66.6	69.9	71	70.5	68.2	77
JULY	70.8	70.9	74.5	76	74.9	72.6	77
AUGUST	66.9	67	71	72	71	68.5	77
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	77
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	77

ENTHALPY FOR AVERAGE WET-BULBS							DESIGN ENTHALPY
	1-4	5-8	9-12	13-16	17-20	21-24	
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	40.57
MAY	24.53	24.21	27.28	29.23	28.57	26.06	40.57
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	40.57
JULY	34.77	34.86	38.14	39.57	38.52	36.37	40.57
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	40.57
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	40.57
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	40.57

COOLING PROFILE OF CENTRAL PLANTS							PEAK LOAD (Btuh)
	1-4	5-8	9-12	13-16	17-20	21-24	
APRIL	0	0	0	0	0	0	0
MAY	0.3	0.3	0.7	0.7	0.3	0.3	1509000
JUNE	0.3	0.3	0.7	0.7	0.3	0.3	1582000
JULY	0.3	0.3	0.7	0.7	0.3	0.3	1582000
AUGUST	0.3	0.3	0.7	0.7	0.3	0.3	1582000
SEPTEMBER	0.3	0.3	0.7	0.7	0.3	0.3	1582000
OCTOBER	0	0	0	0	0	0	0

RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY							DAYS PER MONTH OPER.
	1-4	5-8	9-12	13-16	17-20	21-24	
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	1.8	1.8	1.7	1.6	1.6	1.7	31
JUNE	1.5	1.5	1.3	1.3	1.3	1.4	30
JULY	1.3	1.3	1.1	1.1	1.1	1.2	31
AUGUST	1.5	1.4	1.3	1.2	1.3	1.4	31
SEPTEMBER	1.5	1.5	1.4	1.4	1.4	1.5	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	% DESIGN LOAD						DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	15.9	15.7	40.1	42.6	17.9	16.6	31
JUNE	20.6	20.5	52.7	54.6	23.0	21.4	30
JULY	23.3	23.3	62.4	66.7	27.2	24.8	31
AUGUST	20.7	20.7	54.6	56.6	23.4	21.6	31
SEPTEMBER	19.7	19.6	49.4	50.9	20.9	20.0	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	SINGLE SPEED CONTROL (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	110	109	279	296	124	115	
JUNE	139	138	354	367	155	144	
JULY	161	162	433	463	189	172	
AUGUST	144	144	379	393	163	150	
SEPTEMBER	132	132	332	342	141	134	
OCTOBER	0	0	0	0	0	0	
TOTAL	686	685	1778	1861	771	716	6497

	TWO SPEED CONTROL (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	31	31	78	83	35	32	
JUNE	39	39	131	157	43	40	
JULY	45	45	270	329	53	48	
AUGUST	40	40	162	189	46	42	
SEPTEMBER	37	37	93	107	39	38	
OCTOBER	0	0	0	0	0	0	
TOTAL	192	192	733	864	216	200	2397

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C

[ ] OTHER ________

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 21-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO-5(A) BLDG. 5676	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
2-SPEED COOLING TOWER TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
10 HP 2-SPD MOTOR	1	EA	2.0	2.0	20	39			1358.00	1358.00	$1,397		
2-SPD MOTOR STARTER	1	EA	4.2	4.2	20	82			859.00	859.00	$941		
MOTOR FEEDER	1	LS	4.1	4.1	20	80			20.00	20.00	$100		
REMOVE OLD MOTOR	1	EA	3.3	3.3	20	65					$65		
REMOVE OLD STR	1	EA	4.2	4.2	20	82					$82		
PNEUMATIC THERMOSTAT	2	EA	1.0	2.0	20	39			34.12	68.24	$107		
SUBTOTAL						$388				$2,305	$2,693		
OVERHEAD, BOND	16%					$62				$369	$431		
PROFIT	10%					$39				$231	$269		
COST SUB-TOTAL						$489				$2,905	$3,394		
CONTINGENCY	20%					$98				$581	$679		
SUBTOTAL						$587				$3,486	$4,072		
S&A	5.5%					$32				$192	$224		
TOTAL THIS SHEET						$619				$3,677	$4,296		

DA FORM [illegible] APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5676EC5A
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	4072.
B. SIOH	$	224.
C. DESIGN COST	$	245.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	4087.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	4087.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	14.	$ 56.	11.37	639.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		14.	$ 56.		$ 639.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 211.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 56.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 639.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .16
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 72.78

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5676
ENERGY CONSERVATION OPPORTUNITY: ECO- 5(B)
SYSTEM MODIFICATION: VARIABLE SPEED DRIVE FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO-5, install two-speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	6,497	--	22
ECO	--	1,527	--	5
Savings (Baseline-ECO)	0	4,970	0	17

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	17 MMBtu/Yr	X	$4.0141 /MMBtu	=	$68 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$68**	+	**$0**	=	**$68 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $289 per year

Total: **$0** - **$289** = **($289) per year**

[ECO-SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input (part 7). The control sequence is:

- 0-50% load, fan 1, half speed cycling.
- 50-100% load, fan 1 full speed cycling.

kWh per bin, for % design loads less than 50% load = (fan 1 power kW) * 14% * (%design load / 50) * 4 hours per bin * days per month.

kWh per bin, for % design loads 50% to 100% load = (fan 1 power kW * ((% design load)/ 100) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 5676	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	77
– WATER FLOW (gpm)	525
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	2178.75
HEAT REJECTION CAPACITY (Btu/min)	43575
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	40.57
TOTAL ENTHALPY	60.57
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	32899
MOTOR DATA	
– FAN 1 POWER (kW)	5.6
– FAN 2 POWER (kW)	0
– FAN 3 POWER (kW)	0
– FAN 4 POWER (kW)	0

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET–BULB AVERAGES (4 hour bins)						DESIGN
	1–4	5–8	9–12	13–16	17–20	21–24	WB
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	77
MAY	57.1	56.6	61.2	63.9	63	59.4	77
JUNE	66.8	66.6	69.9	71	70.5	68.2	77
JULY	70.8	70.9	74.5	76	74.9	72.6	77
AUGUST	66.9	67	71	72	71	68.5	77
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	77
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	77

ENTHALPY FOR AVERAGE WET-BULBS	1-4	5-8	9-12	13-16	17-20	21-24	DESIGN ENTHALPY
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	40.57
MAY	24.53	24.21	27.28	29.23	28.57	26.06	40.57
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	40.57
JULY	34.77	34.86	38.14	39.57	38.52	36.37	40.57
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	40.57
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	40.57
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	40.57

COOLING PROFILE OF CENTRAL PLANTS	1-4	5-8	9-12	13-16	17-20	21-24	PEAK LOAD (Btuh)
APRIL	0	0	0	0	0	0	0
MAY	0.3	0.3	0.7	0.7	0.3	0.3	1509000
JUNE	0.3	0.3	0.7	0.7	0.3	0.3	1582000
JULY	0.3	0.3	0.7	0.7	0.3	0.3	1582000
AUGUST	0.3	0.3	0.7	0.7	0.3	0.3	1582000
SEPTEMBER	0.3	0.3	0.7	0.7	0.3	0.3	1582000
OCTOBER	0	0	0	0	0	0	0

RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY	1-4	5-8	9-12	13-16	17-20	21-24	DAYS PER MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	1.8	1.8	1.7	1.6	1.6	1.7	31
JUNE	1.5	1.5	1.3	1.3	1.3	1.4	30
JULY	1.3	1.3	1.1	1.1	1.1	1.2	31
AUGUST	1.5	1.4	1.3	1.2	1.3	1.4	31
SEPTEMBER	1.5	1.5	1.4	1.4	1.4	1.5	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

% DESIGN LOAD							DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	15.9	15.7	40.1	42.6	17.9	16.6	31
JUNE	20.6	20.5	52.7	54.6	23.0	21.4	30
JULY	23.3	23.3	62.4	66.7	27.2	24.8	31
AUGUST	20.7	20.7	54.6	56.6	23.4	21.6	31
SEPTEMBER	19.7	19.6	49.4	50.9	20.9	20.0	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

SINGLE SPEED CONTROL (kWh)							TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	110	109	279	296	124	115	
JUNE	139	138	354	367	155	144	
JULY	161	162	433	463	189	172	
AUGUST	144	144	379	393	163	150	
SEPTEMBER	132	132	332	342	141	134	
OCTOBER	0	0	0	0	0	0	
TOTAL	686	685	1778	1861	771	716	6497

TWO SPEED CONTROL (kWh)							TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	31	31	78	83	35	32	
JUNE	39	39	131	157	43	40	
JULY	45	45	270	329	53	48	
AUGUST	40	40	162	189	46	42	
SEPTEMBER	37	37	93	107	39	38	
OCTOBER	0	0	0	0	0	0	
TOTAL	192	192	733	864	216	200	2397

VARIABLE SPEED COOLING TOWER CYCLING (kWh)							TOTAL
	1-4	5-8	9-12	13-16	17-20	21-24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	3	3	56	67	5	4	
JUNE	7	7	123	137	10	8	
JULY	11	11	211	257	17	13	
AUGUST	8	8	142	157	11	9	
SEPTEMBER	6	6	101	111	8	7	
OCTOBER	0	0	0	0	0	0	
TOTAL	36	36	633	730	52	41	1527

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO BLDG. 5676	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
VARIABLE SPEED COOLING TOWER TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
VFD FOR ONE 10 HP MOTOR	1	EA	4.0	4.0	20	78			2500.00	2500.00	$2,578		
VFD WIRING & CONNECTION	1	LS	4.1	4.1	20	80			20.00	20.00	$100		
WATER TEMPERATURE SENSOR	1	EA	9.0	9.0	20	176			328.00	328.00	$504		
SUBTOTAL						$334				$2,848	$3,182		
OVERHEAD, BOND	16%					$53				$456	$509		
PROFIT	10%					$33				$285	$318		
COST SUB-TOTAL						$421				$3,588	$4,010		
CONTINGENCY	20%					$84				$718	$802		
SUBTOTAL						$505				$4,306	$4,811		
S&A	5.5%					$28				$237	$265		
TOTAL THIS SHEET						$533				$4,543	$5,076		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5676EC5B
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	4811.
B. SIOH	$	265.
C. DESIGN COST	$	289.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	4829.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	4829.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	17.	$ 68.	11.37	774.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		17.	$ 68.		$ 774.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -289.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -3367.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -3367.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 255.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -221.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -2593.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.54
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -21.86

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5676
ENERGY CONSERVATION OPPORTUNITY: ECO-6
SYSTEM MODIFICATION: HIGH EFFICIENCY MOTOR REPLACEMENT
SYSTEMS TO MODIFY: PUMP & COOLING TOWER MOTORS

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-6, install high efficiency motors.
It was estimated that the electrical energy can be saved by installing high efficiency motors based on the motor operating hours per year.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	4	24,287	0	83

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	83 MMBtu/Yr	X	$4.0141 /MMBtu	=	$333 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$333**	+	**$0**	=	**$333 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand:	4 kW/month	X	$1.787 /kW	X	12 months/year
	=	(+)	$86 per year		
Maintenance:	=	(-)	$0 per year		
Total:	**$86**	-	**$0**	=	**$86 per year**

[ECO-SHT.WK3]

HIGH EFFICIENCY MOTOR REPLACEMENT

LABOR RATE:	19.6	$/hr
ELECTRIC CONS.	0.0137	$/kWH
ELECTRIC DEMAND	1.787	$/kW

BLDG. NO.	EQUIPMENT SERVE	MOTOR HP	MOTOR FLA	MEAS AMPS	MEAS PF	MEAS VOLT	EXST EFF	NEW EFF	KW SVGS	HRS/ YEAR	KWH/YR SVGS	SVGS/ YEAR
730	CWP-1	150.0	179.0	147.0	0.87	460	90.19%	95.00%	5.73	2641	15120	$330
	CWP-2	150.0	179.0	148.0	0.91	460	86.22%	95.00%	11.50	1873	21539	$542
	CNWP-1	50.0	118.0	107.0	0.98	230	80.97%	93.00%	6.67	2641	17629	$385
	CNWP-2	50.0	118.0	107.0	0.99	230	80.15%	93.00%	7.27	468	3405	$203
	CNWP-3	NI	NI	NI								
	CTM-1	30.0	71.4	70.7	0.93	230	84.60%	92.40%	2.61	702	1834	$81
	CTM-2	30.0	71.4	71.0	0.87	230	90.44%	92.40%	0.58	702	405	$18
	HWP-1	50.0	125.0	117.5	0.87	230	86.10%	93.00%	3.51	3624	12722	$250
	HWP-2	50.0	125.0	118.0	0.87	230	86.10%	93.00%	3.53	3624	12776	$251
		DEMAND CREDIT		$888	MMBtu	292		TOTAL	41		85430	$2,058
914	CWP-1	40.0	48.0	41.3	0.87	460	89.69%	93.00%	1.14	3672	4178	$82
	CNWP-1	15.0	19.0	14.4	0.82	460	90.15%	90.20%	0.01	3672	23	$0
	CTM-1	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	CTM-2	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	HWP-1	2.0	6.2	5.4	0.87	230	69.43%	84.00%	0.47	3624	1694	$33
	HWP-2	2.0	6.2	5.6	0.87	230	69.43%	84.00%	0.48	3624	1757	$34
		DEMAND CREDIT		$111	MMBtu	30		TOTAL	5		8932	$233
2812	CWP-1	20.0	27.0	23.0	0.77	460	90.07%	91.00%	0.16	3672	586	$11
	CNWP-1	25.0	31.5	26.5	0.82	460	91.18%	91.70%	0.11	3672	394	$8
	CTM-1	15.0	18.6	18.6	0.87	460	86.79%	90.20%	0.56	1167	655	$21
	HWP-1	7.5	21.6	18.5	0.87	230	74.74%	88.50%	1.33	5163	6888	$123
	HWP-2	7.5	21.6	19.0	0.87	230	74.74%	88.50%	1.37	3672	5031	$98
		DEMAND CREDIT		$76	MMBtu	46		TOTAL	4		13554	$261
3442	CWP-1	60.0	73.0	63.0	0.84	460	91.62%	94.50%	1.40	3672	5158	$1[illegible]
	CWP-2	60.0	73.0	63.4	0.84	460	91.62%	94.50%	1.41	3672	5191	$1[illegible]
	CNWP-1	40.0	52.0	41.0	0.78	460	92.34%	93.00%	0.20	3672	721	$14
	CNWP-2	40.0	52.0	35.8	0.78	460	92.34%	93.00%	0.17	3672	629	$12
	CTM-1	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-2	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-3	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-4	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
		DEMAND CREDIT		$90	MMBtu	44		TOTAL	4		12880	$266
4701	CWP-1	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CWP-2	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CNWP-1	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CNWP-2	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CTM-1	20.0	24.6	18.2	0.87	460	87.50%	91.00%	0.55	650	361	$17
	CTM-2	15.0	19.2	16.5	0.87	440	87.90%	90.20%	0.32	650	206	$10
		DEMAND CREDIT		$65	MMBtu	16		TOTAL	3		4605	$128
5676	HCP-1	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	HCP-2	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	10.5	9	0.79	460	84.66%	88.50%	0.29	1160	337	$11
		DEMAND CREDIT		$94	MMBtu	83		TOTAL	4		24287	$427
5678	HCP-1	2.0	6.5	5.9	0.83	208	76.76%	84.00%	0.20	7296	1445	$24
	HCP-2	2.0	6.5	5.7	0.83	208	76.76%	84.00%	0.19	7296	1396	$23
	HCP-3	1.5	4.8	4.5	0.83	230	70.51%	84.00%	0.34	7296	2474	$41
	HCP-4	2.0	6.3	5.8	0.83	230	71.62%	84.00%	0.39	7296	2878	$48
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	11	9.6	0.75	460	85.12%	88.50%	0.26	1139	293	$10
		DEMAND CREDIT		$64	MMBtu	49		TOTAL	3		14412	$262

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C
[ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 10-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

MOTOR REP. ECO BLDG. 5676	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
HIGH EFF. MOTOR REP.LACEMENT TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
HCP-1 10.0 HP MOTOR	1	EA	3.6	3.6	20	71			750.0	750.00	$821		
HCP-2 10.0 HP MOTOR	1	EA	3.6	3.6	20	71			750.0	750.00	$821		
CNWP-1 7.5 HP MOTOR	1	EA	3.4	3.4	20	67			616.0	616.00	$683		
CTM-1 7.5 HP MOTOR	1	EA	3.4	3.4	20	67			616.0	616.00	$683		
SUBTOTAL						$275				$2,732	$3,007		
OVERHEAD, BOND	16%					$44				$437	$481		
PROFIT	10%					$28				$273	$301		
COST SUB-TOTAL						$347				$3,442	$3,789		
CONTINGENCY	20%					$69				$688	$758		
SUBTOTAL						$416				$4,131	$4,547		
S&A	5.5%					$23				$227	$250		
TOTAL THIS SHEET						$439				$4,358	$4,797		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5676EC6
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: HIGH EFF. MOTOR
ANALYSIS DATE: 04-10-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	4547.
B. SIOH	$	250.
C. DESIGN COST	$	273.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	4563.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	4563.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	83.	$ 333.	11.37	3784.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		83.	$ 333.		$ 3784.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 86.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 1002.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 1002.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1249.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 419.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 4785.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.05
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 10.90

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5676
ENERGY CONSERVATION OPPORTUNITY: ECO-7
SYSTEM MODIFICATION: INSTALL INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for
ECO-7, install instrumentation to facilitate efficient operation of boiler plant.
It was estimated that the energy wasted from boiler in standby is 1% of the rated
output capacity. The hours when boilers are running unnecessary were estimated for each boiler.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	0	0	13	13

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	13 MMBtu/Yr	X	$2.92 /MMBtu	=	$38 per year
Total Energy Cost Savings:	**$0**	**+**	**$38**	**=**	**$38 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $320 per year

Total: $0 - $320 = ($320) per year

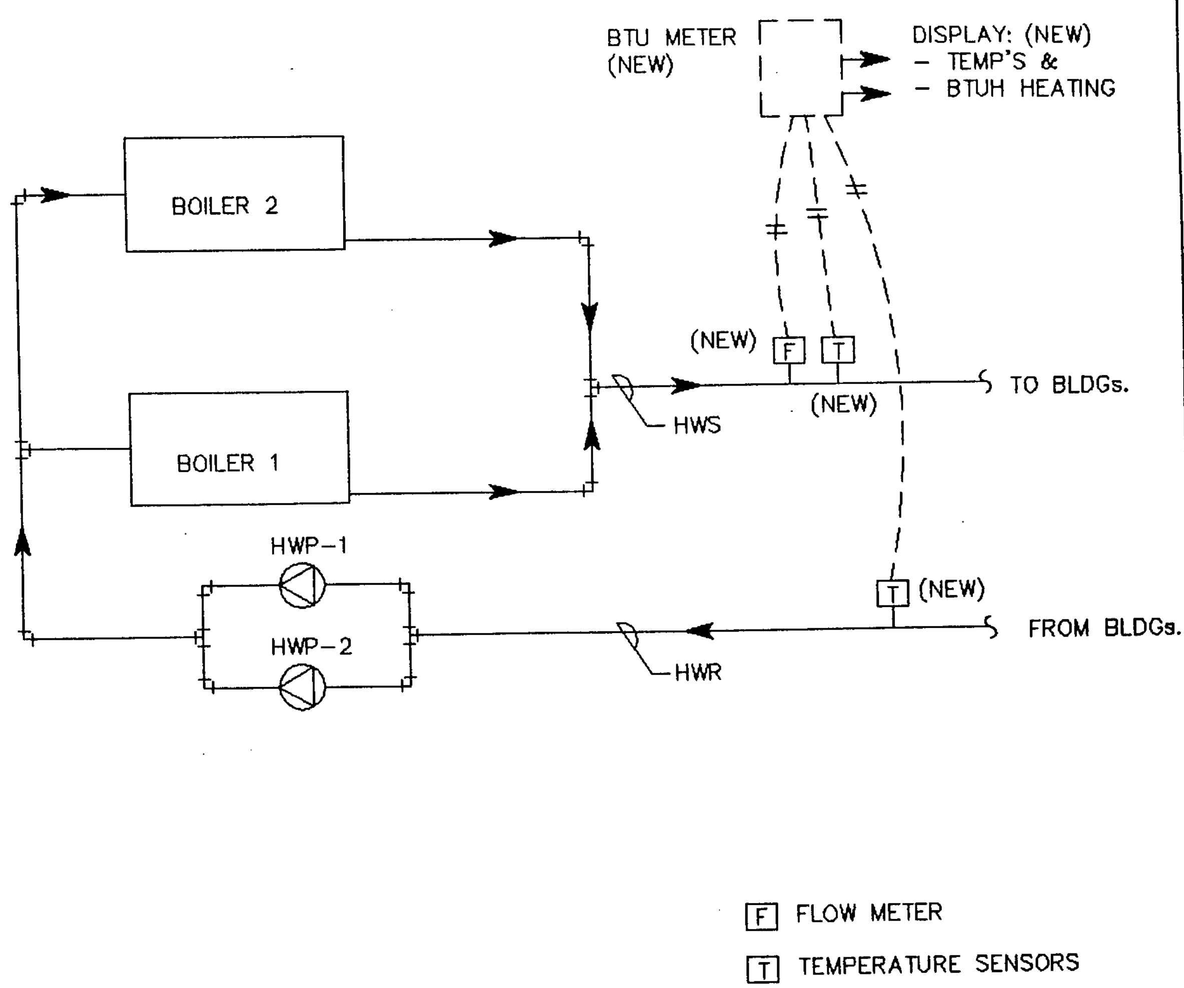
[ECO-SHT.WK3]

BOILER STANDBY SAVINGS

CENTRAL PLANT	BOILER NO.	BOILER TYPE	BOILER MANUFACTURERER	BOILER MODEL NUMBER	RATED BOILER OUTPUT MMBTU/H	CALC. BOILER OUTPUT MMBTU/H	STANDBY LOSS (1%) MMBTU/H	EXCESS STANDBY (HRS/YR)	EXCESS STANDBY MMBTU/H	EXCESS STANDBY SAVINGS ($)
5900	1	HTHW	INTERNATIONAL	D-12	10.00	6.94	0.0694	0		
	2	HTHW	INTERNATIONAL	D-12	10.00	7.17	0.0717	720	51.62	$150.74
	3	HTHW	HERCULES	300	9.70	7.61	0.0761	720	54.82	$160.09
	4	HTHW	HERCULES	300	9.70	7.58	0.0758	720	54.55	$159.27
	5	HTHW	INTERNATIONAL	1035 TH12	8.00	6.22	0.0622	0		
	6	HTHW	INTERNATIONAL	TJW-C-10	11.20	8.88	0.0888	0		
						TOTAL		2160	160.99	$470.10
6003	1	STEAM-12	KEWANEE	L39-350-605	11.72	9.41	0.0941	0		
	2	STEAM-12	YORK SHIPLEY	SPL-350-112080	11.72	9.12	0.0912	0		
	3	STEAM-12	KEWANEE	L36-350-605	11.72	9.37	0.0937	720	67.45	$196.96
						TOTAL		720	67.45	$196.96
730	1	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	0		
	2	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	720	44.34	$129.47
	3	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.18	0.0618	720	44.51	$129.96
	4	STEAM-12	KEWANEE	CAT#7L280-KG-06	2.66	2.11	0.0211	0		
						TOTAL		1440	88.84	$259.43
2812	1	STEAM-12	FEDERAL BOILER CO	GS 3562	1.80	1.40	0.0140	0		
	2	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.77	0.0277	0		
	3	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.86	0.0286	720	20.62	$60.21
						TOTAL		720	20.62	$60.21
5676	1	HW	AMERICAN STANDARD	PF 515	2.44	1.80	0.0180	720	12.93	$37.76
	2	HW	AMERICAN STANDARD	PF 515	2.44	1.71	0.0171	0		
						TOTAL		720	12.93	$37.76
5678	1	HW	BRUNHAM	PF 514	2.27	1.50	0.0150	720	10.79	$31.50
	2	HW	BRUNHAM	PF 514	2.27	1.63	0.0163	0		
						TOTAL		720	10.79	$31.50
914	1	STEAM-12	BRUNHAM	PF-510	1.61	1.29	0.0129	0		
	2	HW	RAY-PAK	EA 200ITB	1.61	1.22	0.0122	0		
	3	HW	AMERICAN STANDARD	G1015	1.92	1.47	0.0147	720	10.56	$30.84
	4	HW	AMERICAN STANDARD	G1015	1.92	1.40	0.0140	0		
						TOTAL		720	10.56	$30.84
4701	1	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	0		
	2	STEAM-100	BIRCHFIELD	FBH 578	11.00	0.00	0.0000	0		
	3	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	720	60.73	$177.33
						TOTAL		720	60.73	$177.33

[BOILERS.WK3]

ECO-7, INSTRUMENTATION FOR BOILER PLANT
(TYPICAL)



[B-ECO-7.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C

OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

DRAWING NO.

SHT OF

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO BLDG. 5676 INSTRUMENTATION	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 2 HW BOILERS													
HWS TEMPERATURE SENSOR	1	EA			176	176			328.00	328.00	$504		
HWR TEMPERATURE SENSOR	1	EA			176	176			328.00	328.00	$504		
INSERT. FLOW METER	1	EA			197	197			764.00	764.00	$961		
BTU METER	1	EA	6.0	6.0	20	118			820.00	820.00	$938		
LED DISPLAY	2	EA							60.00	120.00	$120		
LED INSTALLATION	2	EA	4.6	9.2	19.6	180			158	316	496.32		
SUBTOTAL						$847				$2,676	$3,523		
OVERHEAD, BOND	16%					$136				$428	$564		
PROFIT	10%					$85				$268	$352		
COST SUB-TOTAL						$1,067				$3,372	$4,439		
CONTINGENCY	20%					$213				$674	$888		
SUBTOTAL						$1,281				$4,046	$5,327		
S&A	5.5%					$70				$223	$293		
TOTAL THIS SHEET						$1,351				$4,269	$5,620		

DA FORM R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: B5676EC1

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.035

INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3

PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS

FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER INSTRUMENTATION

ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	5327.
B. SIOH	$	293.
C. DESIGN COST	$	320.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	5346.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	5346.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	13.	$ 38.	12.48	471.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		13.	$ 38.		$ 471.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -320.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -2915.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -2915.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 155.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -282.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -2444.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.46
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -18.94

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5676
ENERGY CONSERVATION OPPORTUNITY: ECO-9
SYSTEM MODIFICATION: REPLACE BOILER WITH HIGHER EFFICIENCY BOILER
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-9, renovate or replace existing boilers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	--	13,462	13,462
ECO	--	--	9,942	9,942
Savings (Baseline-ECO)	0	0	3,520	3,520

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	3520 MMBtu/Yr	X	$2.92 /MMBtu	=	$10,278 per year
Total Energy Cost Savings:	**$0**	+	**$10,278**	=	**$10,278 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $0 per year

Total: **$0** - **$0** = **$0 per year**

[ECO-SHT.WK3]

CENTRAL PLANT 5676 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	13463.
PEAK DAY GAS CONSUMP., 1000 CU FT	137.
ELECTRICAL CONSUMPTION, KWH	298696.
PEAK KW DEMAND (15 MIN BASIS)	165.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	298696.
ON-PEAK KW DEMAND (15 MIN BASIS)	165.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2057
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BOILER ECO-3

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	9942.
PEAK DAY GAS CONSUMP., 1000 CU FT	100.
ELECTRICAL CONSUMPTION, KWH	298696.
PEAK KW DEMAND (15 MIN BASIS)	165.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	298696.
ON-PEAK KW DEMAND (15 MIN BASIS)	165.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	1541
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER LOCATION FT. SILL, OKLAHOMA	INVITATION NO./CONTRACT NO. DACA 59-90-C-0087 CODE A [X] CODE B [ ] CODE C [ ] OTHER	EFFECTIVE PRICING DATE APR. 91 DRAWING NO. ESTIMATOR KC	DATE PREPARED 08-Apr-91 SHT OF CHECKED BY CEL

BOILER ECO BLDG. 5676 / BOILER REPLACEMENT / TASK DESCRIPTION	Quantity: No. Of Units	Quantity: Unit Meas	LABOR: MH/ Unit	LABOR: Total Hrs	LABOR: Unit Price	LABOR: Cost	EQUIPMENT: Unit Price	EQUIPMENT: Cost	MATERIAL: Unit Price	MATERIAL: Cost	TOTAL	SHIPPING: Unit Wt	SHIPPING: Total Wt
REPLACEMENT OF BOILER 1 AND 2													
2.6 MMBtu GAS FIRED BOILER	2	EA	100.0	200.0	24	$4,800			$29,900	$59,800	$64,600		
REMOVE OF EXISTING BOILERS	2	EA	30.0	60.0	24	$1,440					$1,440		
SUBTOTAL						$6,240				$59,800	$66,040		
OVERHEAD, BOND	16.0%					$998				$9,568	$10,566		
PROFIT	10.0%					$624				$5,980	$6,604		
COST SUB-TOTAL						$7,862				$75,348	$83,210		
CONTINGENCY	20.0%					$1,572				$15,070	$16,642		
SUBTOTAL						$9,435				$90,418	$99,852		
S&A	5.5%					$519				$4,973	$5,492		
TOTAL THIS SHEET						$9,954				$95,391	$105,344		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: B5676EC3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER REPLACEMENT
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	99852.
B. SIOH	$	5492.
C. DESIGN COST	$	5992.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	100202.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	100202.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	3520.	$ 10278.	17.52	180078.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		3520.	$ 10278.		$ 180078.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1792.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -20877.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -20877.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 59426.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 8486.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 159201.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.59
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 11.81

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5676
ENERGY CONSERVATION OPPORTUNITY: ECO-10
SYSTEM MODIFICATION: OXYGEN TRIM FOR BURNERS
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-10, install oxygen trim for burners.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	13,462	13,462
ECO	--	--	13,224	13,224
Savings (Baseline-ECO)	0	0	238	238

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	238 MMBtu/Yr	X	$2.92 /MMBtu	=	$695 per year
Total Energy Cost Savings:	**$0**	+	**$695**	=	**$695 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $1,799 per year

Total: **$0** - **$1,799** = **($1,799) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	13463.
PEAK DAY GAS CONSUMP., 1000 CU FT	137.
ELECTRICAL CONSUMPTION, KWH	298696.
PEAK KW DEMAND (15 MIN BASIS)	165.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	298696.
ON-PEAK KW DEMAND (15 MIN BASIS)	165.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2057
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BOILER ECO-4

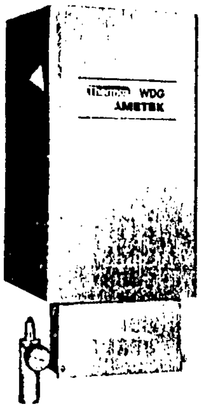
** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	13224.
PEAK DAY GAS CONSUMP., 1000 CU FT	135.
ELECTRICAL CONSUMPTION, KWH	298696.
PEAK KW DEMAND (15 MIN BASIS)	165.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	298696.
ON-PEAK KW DEMAND (15 MIN BASIS)	165.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2030
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

SPECIFICATIONS – AIR-MIZER II SYSTEM

SENSOR



Nominal Dimensions: $14\frac{5}{8}$"H x $10\frac{1}{4}$"W x 10"D (37.2 x 26 x 25.4 cm)

Enclosure: Weather resistant—S.S. case, nickel plated carbon steel base

Weight: 55 pounds (25 kg)

Accuracy: ±1% of net excess oxygen

Repeatability: ±0.2% of measured value

Response: 90% of full scale in less than 5 seconds

Drift: Less than 0.1% of sensor cell output per month

Ambient Temperatures: −5 to +175°F (−20.5 to +79°C)

Sample Temperatures: Up to 1300°F (704°C) with standard probe

Sample Flow Rate: 0.1 to 120 scfh (0.47 to 56.65 liters/minute)

Air Aspirator Requirements: 10 to 20 scfh (4.72 to 14.16 liters/ min) at 15-100 psi (1.05 to 7.037 kg/cm^2) (Aspirator air regulator furnished with sensor normally set at 2-7 psi; 0.14 - 0.49 kg/cm^2)

Calibration: With analyzed oxygen in nitrogen sample. Calibration port provided.

CONTROL UNIT

Nominal Dimensions: $12\frac{5}{8}$"H x $10\frac{7}{8}$"W x $9\frac{1}{8}$"D (32.1 x 27.6 x 23.2 cm)

Enclosure: Wall/panel mounted—meets the requirements for NEMA 4 areas

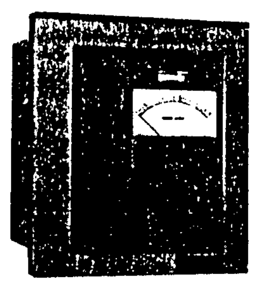
Weight: 22 pounds (10 kg)

Temperature Control: On-Off by microprocessor (±1°C)

Linearization: 256 segments from 20% to 0.2% O_2, (218 from 10% to 0.2%), by microprocessor

Controller Action: On-Off—"On" time adjustable 2-20 seconds. "Off" time adjustable 2-60 seconds.
Deadband: ± 0.25% oxygen.
LED's indicate motor driving.
Will not allow decrease in air when O_2 is below 0.5% oxygen. Air flow will increase to +15% max. If O_2 level is above 12%.

Setpoint: 0 to 10% oxygen by either of: A. Two banks of 5 slide pots, (Dual Fuel) selectable by slide switch; proper pot or pots connected to processor by switch in actuator. B. Manual pot on panel A or B selected by Remote/Local switch on panel. Setpoint indicated by edge reading meter (0-10%)



Manual Control: Manual/Auto switch and increase—decrease push buttons (Spring return switch inside control unit can override all control actions in the event of processor failure).

Ready Indicator: On at temperature set point. Off below temperature set point. Flashes above temperature set point. O_2 Control in "manual" when below set point.

Oxygen Scale: 20.9 to 0.1% O_2 Logarithmic

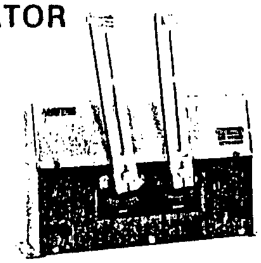
Alarms: High and Low O_2 adjustable 0.2 to 20%. RTD Failure (shuts down temperature control, and puts O_2 control in "manual").

Increase Air Override: Contact closure from optional combustibles or smoke detector alarm will cause increase in air signal on each control pulse regardless or O_2 vs. O_2 setpoint relationship. Once combustibles contact opens, normal control will resume. This maintains air flow at a level where maximum allowable combustibles or smoke is not exceeded.

Ambient Temperature Limits: 32°F to 140°F (0 to +60°C)

Recorder Output: 0-100 mv = 0-20% O_2 Linear (0-50 mv = 0-10%) Other current or voltages outputs optional

ACTUATOR



Overall Size: $17\frac{1}{2}$"L x 4"W x $10\frac{1}{4}$"H (44.5 x 10.2 x 26 cm)

Weight: 16.5 pounds (7.5 kg)

Angular Travel (Input Arm): 60°

Linear Link Travel: Adjustable 4" to 10" at 4" to 10" Radius (10.2 to 25.4 cm at 10.2 to 25.4 cm Radius)

Linear Link Force: 100 pounds at 4" Radius (45.5 kg at 10.2 cm Radius)
70 pounds at 6" Radius (31.8 kg at 15.2 cm Radius)
40 pounds at 10" Radius (18.2 kg at 25.4 cm Radius)

Case: Suitable for areas requiring NEMA 2 equipment (Drip proof indoor)

Correction: −15% to +15% (.85 to 1.15 gain) of normal air flow

Speed: 60 seconds from −15% to +15% correction (max.)

Load Indication: 9 position shorting switch tied to input arm

Brake: Internal brake will hold load at any above rated force without "coasting"

Ambient Temperature Limits: 0°F to 160°F (−18 to +71°C)

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.
DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ]
OTHER

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

BOILER ECO BLDG. 5676	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
BOILER CONTROL O2 TRIM TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
O2 TRIM CONTROL	2	EA			3000	$6,000			$1,800	$9,590	$15,590		
ANNUAL RECURRING COST													
OXYGEN SENSOR	2	EA	0.5	1.0	24	$24			$420	$840	$864		
OTHER MAINTENANCE COST	1	LS							$935	$935	$935		
ANNUAL TOTAL											$1,799		
SUBTOTAL						$6,000				$9,590	$15,590		
OVERHEAD, BOND	16.0%					$960				$1,534	$2,494		
PROFIT	10.0%					$600				$959	$1,559		
COST SUB-TOTAL						$7,560				$12,083	$19,643		
CONTINGENCY	20.0%					$1,512				$2,417	$3,929		
SUBTOTAL						$9,072				$14,500	$23,572		
S&A	5.5%					$499				$798	$1,296		
TOTAL THIS SHEET						$9,571				$15,298	$24,869		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5676EC10
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER O2 TRIM CONTROL
ANALYSIS DATE: 04-10-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1.	INVESTMENT		
	A. CONSTRUCTION COST	$	23572.
	B. SIOH	$	1297.
	C. DESIGN COST	$	1415.
	D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	23656.
	E. SALVAGE VALUE COST	-$	0.
	F. TOTAL INVESTMENT (1D-1E)	$	23656.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	238.	$ 695.	12.48	8673.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		238.	$ 695.		$ 8673.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1799.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -16389.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -16389.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 2862.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -1104.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -7716.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.33
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -21.43

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5676
ENERGY CONSERVATION OPPORTUNITY: ECO-12
SYSTEM MODIFICATION: STACK ECONOMIZERS
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-12, install stack economizer for boilers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	13,462	13,462
ECO	--	--	12,744	12,744
Savings (Baseline-ECO)	0	0	718	718

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	718 MMBtu/Yr	X	$2.92 /MMBtu	=	$2,097 per year
Total Energy Cost Savings:	**$0**	+	**$2,097**	=	**$2,097 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year
= (+) $0 per year

Maintenance: = (-) $0 per year

Total: **$0** - **$0** = **$0 per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5676 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	13463.
PEAK DAY GAS CONSUMP., 1000 CU FT	137.
ELECTRICAL CONSUMPTION, KWH	298696.
PEAK KW DEMAND (15 MIN BASIS)	165.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	298696.
ON-PEAK KW DEMAND (15 MIN BASIS)	165.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2057
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

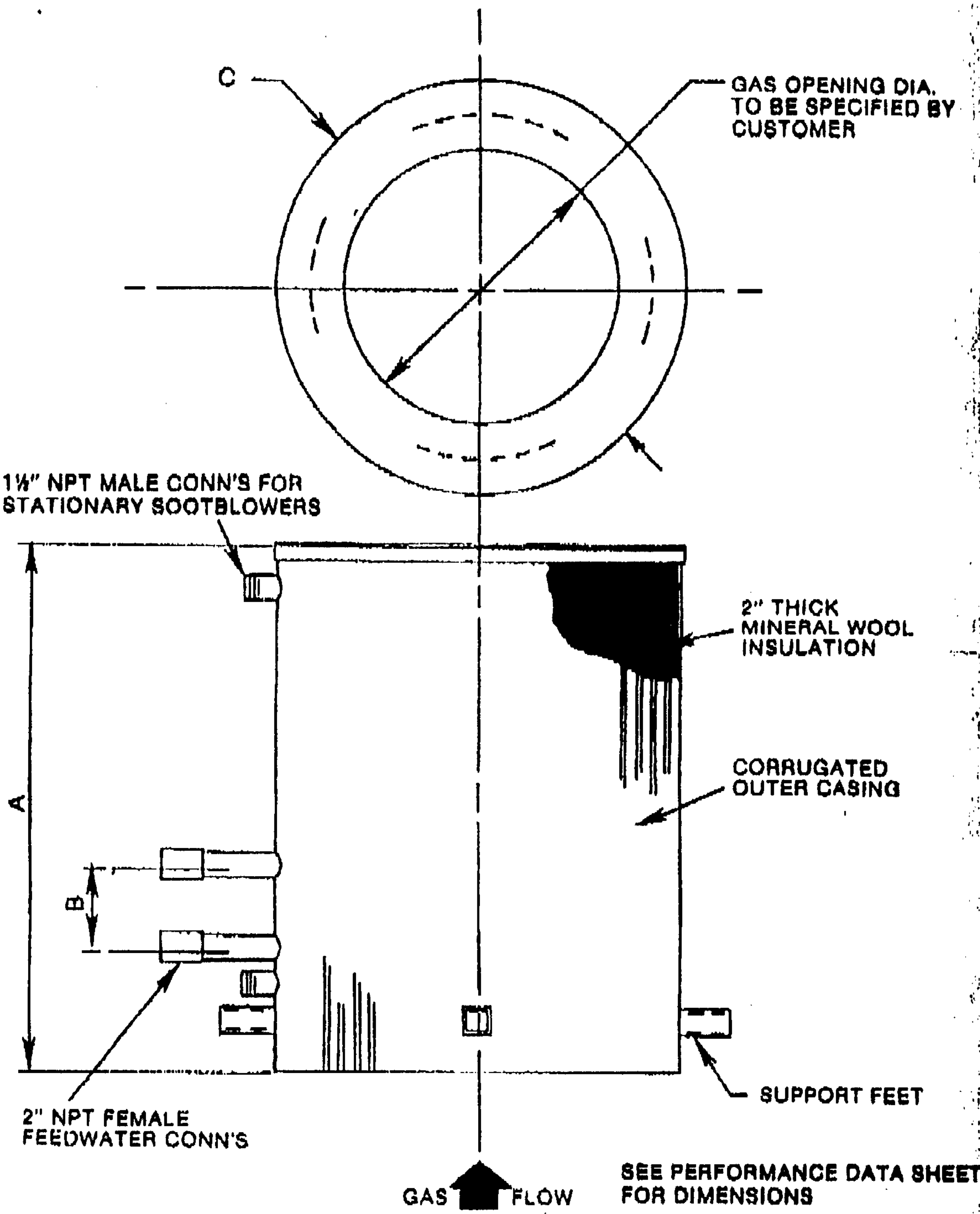
CENTRAL PLANT 5676 BOILER ECO-6

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	12744.
PEAK DAY GAS CONSUMP., 1000 CU FT	129.
ELECTRICAL CONSUMPTION, KWH	298696.
PEAK KW DEMAND (15 MIN BASIS)	165.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	298696.
ON-PEAK KW DEMAND (15 MIN BASIS)	165.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	1994
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Kentube Cylindrical [illegible]® Fuel Economizer



SEE PERFORMANCE DATA SHEET FOR DIMENSIONS

Kentube
4150 South Elwood • Tulsa, Oklahoma 47107
918/446-4561 • Telex: 49-2353

CRFE-V4

OFT
CUSTOMER
EMC Engineers
PROPOSAL 318-10350-0-0
RUN 00

KENTUBE
4150 S. ELWOOD
TULSA, OKLAHOMA

PRINTED 04/10/91
TIME 09 HRS 06 MINS
CUST. REFERENCE

CYLINDRICAL FUEL ECONOMIZER MODEL 201140

OVERALL PERFORMANCE

COUNTER CURRENT FLOW
FLUID CIRCULATED IN TUBES IS WATER

HEAT EXCHANGED	552023.	BTU/HR
U EXTERNAL	6.938	BTU/HR-SQFT-F
LMTD	160.3	DEG F

OVERALL CONSTRUCTION

VERTICAL GAS FLOW
DIMENSIONS

DIM A	(HEIGHT)	7'-3/4"
DIM B	(NOZ C-C)	0'-5 1/2"
DIM C	(DIAMETER)	2'-9 3/4"
DRAWING NO		V- 4

SOOT BLOWERS ARE BUILT IN

NOZZLE SIZE	2.0	IN
SURFACE AREA	496.	SQFT
LIQUID WEIGHT	175.	LB
UNIT WEIGHT(DRY)	1768.	LB

PERFORMANCE SPECIFICATIONS

	TUBE SIDE ↓	GAS SIDE ↑	
FLOW RATE	8620.	10307.	LB/HR
TEMP IN	180.0	500.0	DEG F
TEMP OUT	243.9	299.1	DEG F
PRES IN	150.0 PSIG	14.7	PSIA
PRES DROP	1.1 PSI	.77	IN WATER

CONSTRUCTION SPECIFICATIONS

TUBE SIDE

DESIGN PRESSURE		490.	PSI
TEST PRESSURE		735.	PSI
DESIGN TEMPERATURE		700.	DEG
TUBE	OUTSIDE DIA	2.000	IN
	MATERIAL	C/STL.	
FIN	THICKNESS	.060	IN
	PITCH	4.00	FINS.
	MATERIAL	C/STL.	
INSULATION			
	MATERIAL	MINERAL WOOl	
	THICKNESS	2.0	IN

Kentube DIVISION FINTUBE CORPORATION
FABRICATED PRODUCTS

4150 S. Elwood
Tulsa, Oklahoma 74107
Phone: (918) 446-4561
FAX: (918) 446-6340

QUOTATION

TO			
EMC Engineers 2750 South Wadsworth Blvd. Denver, CO 80227 Attention: Mr. Dennis Jones	QUOTATION DATE 04/10/91	YOUR REFERENCE	OUR REFERENCE 318-10350-0-0
	SHIPPING ESTIMATE 8 Weeks*	TERMS Net 30 Days	PAGE 1 OF 2
	SHIPPING DESTINATION	F.O.B. Kentube Shop**	

THANK YOU FOR YOUR INQUIRY. WE APPRECIATE THE OPPORTUNITY TO PROPOSE THE FOLLOWING:

ITEM	QUANTITY	DESCRIPTION	UNIT AMOUNT	AMOUNT
	8	Kentube RETROMISER Fuel Economizer Cylindrical Model 201140, in accordance with the attached performance specifications. DESIGN FEATURES Finned tube unit; 4 Fins per inch; Vertical gas flow; Counter-current flow Fuel type: NATURAL GAS. Estimated Shipping Weight - 1768. LBS. Pressure parts to Section I of the ASME Boiler & Pressure Vessel Code. External 2" insulation with weatherproof, corrugated casing is included. Threaded drain and vent connections included. Kentube manually operated sootblower, integral with unit, included. Requires 85 psig to 250 psig supply pressure.	$ 4914.	$ 39312.

ENCLOSURES
cc: Ted D. Miller Associates

NOTE: All shipping estimates are based on "after receipt of order" and "after final print approvals" as required. Shipments can often be improved upon request. Please contact Kentube.
Prices firm for 30 days and subject to change thereafter. No provision is made for Federal, State or Municipal taxes. All orders are subject to acceptance or rejection by the Credit Department of Kentube and to the Terms of Sale attached.

YOUR REPRESENTATIVE IS:	YOUR ORDER WILL RECEIVE OUR PROMPT ATTENTION
Ted D. Miller Associates 2140 South Ivanhoe Denver, CO 80222	KENTUBE FABRICATED PRODUCTS Larry Wolf Larry Wolfenbarger Product Sales Engineer

Kentube

FABRICATED PRODUCTS

QUOTATION

TO	EMC Engineers	/318-10350-0-0

ITEM	QUANTITY	DESCRIPTION	UNIT AMOUNT	AMOUNT
		SUGGESTED ACCESSORIES (Quantities below are for each unit)		
	1	Bolted access manway in casing, approximately 16" Square, carbon steel construction.	$ 300.	$ 300.
	1	1/2" Threaded connection for safety relief valve on header.	$ 100.	$ 100.
	1	1/2" Threaded safety relief valve, Kunkle series 927.	$ 555.	$ 555.
		** All prepaid and bill shipments will be at the billable freight amount plus a service charge of 10%. A service charge is not required for collect shipments or third party billing.		
		* KENTUBE is a member of the AMERICAN BOILER MANUFACTURERS ASSOCIATION *		

COST ESTIMATE ANALYSIS

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER LOCATION FT. SILL, OKLAHOMA	INVITATION NO./CONTRACT NO. DACA 59-90-C-0087 CODE A [X] CODE B [ ] CODE C OTHER ______	EFFECTIVE PRICING DATE APR. 91 DRAWING NO. ESTIMATOR KC	DATE PREPARED 11-Apr-91 SHT OF CHECKED BY CEL

STACK ECONOMIZER ECO BLDG. 5676 TASK DESCRIPTION	Quantity No. Of Units	Quantity Unit Meas	LABOR MH/ Unit	LABOR Total Hrs	LABOR Unit Price	LABOR Cost	EQUIPMENT Unit Price	EQUIPMENT Cost	MATERIAL Unit Price	MATERIAL Cost	TOTAL	SHIPPING Unit Wt	SHIPPING Total Wt
STACK ECONOMIZER & ACC.	2	EA	247.9	495.8	24	11900			3966.00	7932.00	$19,832	742	1484
SUBTOTAL						$11,900				$7,932	$19,832		
OVERHEAD, BOND	16%					$1,904				$1,269	$3,173		
PROFIT	10%					$1,190				$793	$1,983		
COST SUB-TOTAL						$14,994				$9,994	$24,988		
CONTINGENCY	20%					$2,999				$1,999	$4,998		
SUBTOTAL						$17,993				$11,993	$29,986		
S&A	5.5%					$990				$660	$1,649		
TOTA[illegible]IS SHEET						$18,982				$12,653	$31,635		

DA FOR[illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5676EC11
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY STUDY ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ECONOMIZER AIR PREHEAT
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	29286.
B. SIOH	$	1611.
C. DESIGN COST	$	1758.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	29390.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	29390.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	718.	$ 2097.	17.52	36732.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		718.	$ 2097.		$ 36732.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 12121.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 2097.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 36732.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.25
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 14.02

CENTRAL PLANT 5678

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5678
ENERGY CONSERVATION OPPORTUNITY: ECO-4
SYSTEM MODIFICATION: INSTALL ICE STORAGE COOLING SYSTEM
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Hand calculation sheet was prepared to determine the energy savings for ECO-4, install ice storage system for HVAC cooling.
It was estimated that the peak electrical demand can be saved by installing ice storage cooling system.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	142	0	0	0

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$0**	+	**$0**	=	**$0 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 142 kW/month X $1.787 /kW X 12 months/year

= (+) $3,045 per year

Maintenance: = (-) $0 per year

Total: **$3,045** - **$0** = **$3,045 per year**

[ECO-SHT.WK3]

A new application of an old idea that can cut air conditioning energy costs in half.

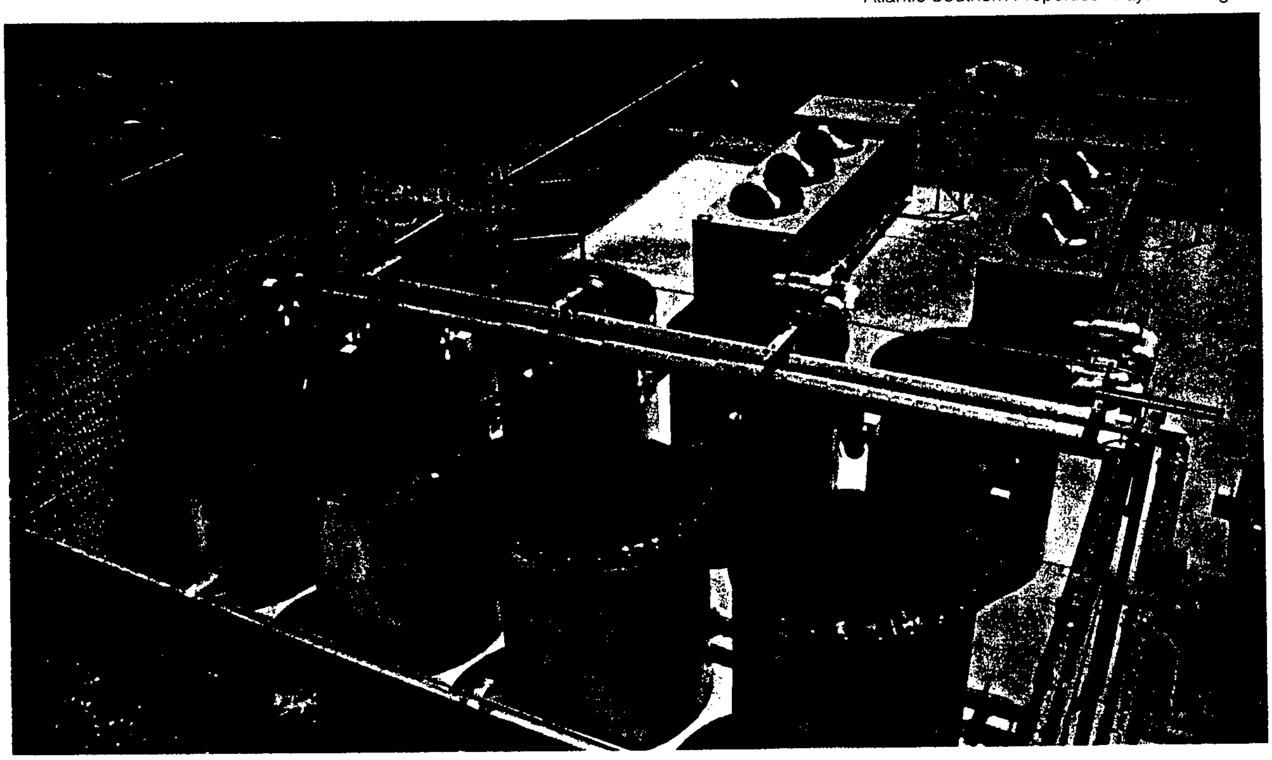
Air conditioning during summer daytime hours is the largest single contributor to utility "peak demand" charges. After noon, as more air conditioners are needed to maintain comfortable temperatures, the increased demand for electricity adds to that already created by lighting, operating equipment, computers and thousands of other uses. This requires the utility to bring additional, more costly generating sources on line to handle its increased demand. Commercial users whose large air conditioning loads contribute to these added generating requirements are assessed an additional charge based on their highest on-peak demand for electricity.

An Ice Bank Stored Cooling System is either a load-shifting or load-leveling method which will significantly lower demand charges during the air conditioning season and, consequently, energy costs. It uses a standard packaged chiller to produce solid ice at night during off-peak periods when the building's electrical needs are at a minimum. The ice is built and stored in modular ice tanks to provide cooling to help meet the building's air conditioning load requirement the following day.

Making ice at night and using its stored energy during the day is not a new or experimental idea. This concept had been employed for years in cooling short-peak applications such as churches and theatres. However, longer peak uses were served by air-source rooftop and chiller-type air conditioners which were less costly to install. Now there is renewed interest in a broad use of ice-making systems by both users and utilities as the best way to offset rising operating costs. In fact, Stored Cooling Systems are what summer-peaking utilities *must have* to avoid the unbearable costs of new generating plants.

Ice Banks not only can cut operating costs in half but they can also substantially reduce capital outlays when systems are suitably designed for new commercial and industrial buildings. Engineers can specify half-size chillers operating 24 hours a day rather than full-size chillers operating only 10 or 12 hours per day. In retrofit applications, an Ice Bank Stored Cooling System can often provide cooling for an addition to a building without adding chiller capacity.

Atlantic Southern Properties Mays Landing NJ



How the LEVLOAD System Works

The LEVLOAD Ice Bank is a modular, insulated polyethylene tank containing a spiral-wound plastic tube heat exchanger surrounded with water. They are available in four sizes – 90, 100, 190 and 570 ton-hours. At night, a 75 percent water - 25 percent glycol solution from a standard packaged air conditioning chiller circulates through the heat exchanger and extracts heat until eventually all the water in the tank is frozen solid. The ice is built uniformly throughout the tank by the patented temperature-averaging effect of closely spaced counterflow heat exchanger tubes, Figure 5. Water does not become surrounded by ice during the freezing process and can move freely as ice forms, preventing stress or damage to the tank.

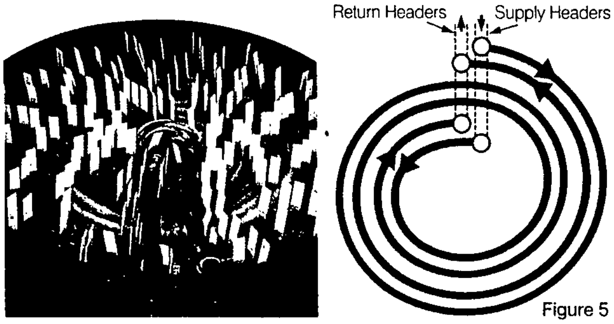


Figure 5

Typical flow diagrams for a Partial Storage System are shown in Figures 6 and 7.

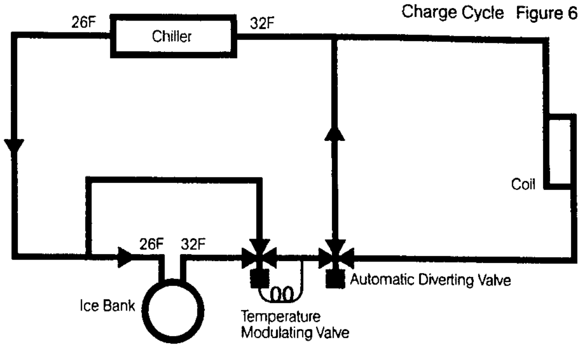
At night, the water-glycol solution circulates through the chiller and the Ice Bank heat exchanger, bypassing the air handler coil. The fluid is at 26F and freezes the water surrounding the heat exchanger.

During the day, the solution is cooled by the Ice Bank from 52F to 34F. A temperature modulating valve set at 44F in a bypass loop around the Ice Bank permits a sufficient quantity of 52F fluid to bypass the Ice Bank, mix with the 34F fluid, and achieve the desired 44F temperature. The 44F fluid enters the coil, where it cools air from 75F to 55F. The fluid leaves the coil at 60F, enters the chiller and is cooled to 52F.

It should be noted that, while making ice at night, the chiller must cool the water-glycol solution to 26F, rather than produce 44 or 45F water temperatures required for conventional air conditioning systems. This has the effect of "derating" the nominal chiller capacity by approximately 30 percent. Compressor efficiency, however, is only slightly reduced because lower nighttime temperatures result in cooler condenser water from the cooling tower and help keep the unit operating efficiently. Similarly, air cooled chillers benefit from cooler condenser entering air temperatures at night.

The temperature modulating valve in the bypass loop has the added advantage of providing unlimited capacity control. During many mild temperature days in the spring and fall, the chiller will be capable of providing all the necessary cooling for the building without assistance from stored cooling. When the building's actual cooling load is equal to or lower than the chiller capacity, all of the system coolant flows through the bypass loop, as in Figure 8.

Charge Cycle Figure 6



Discharge Cycle Figure 7

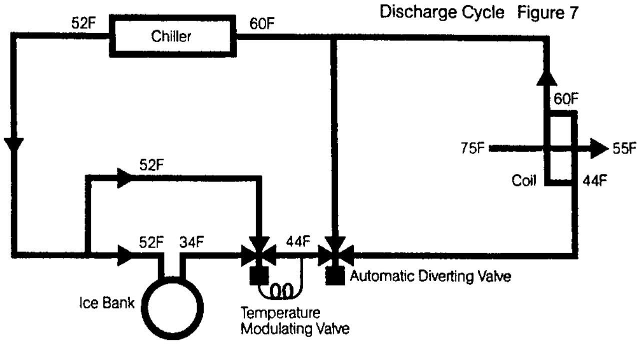
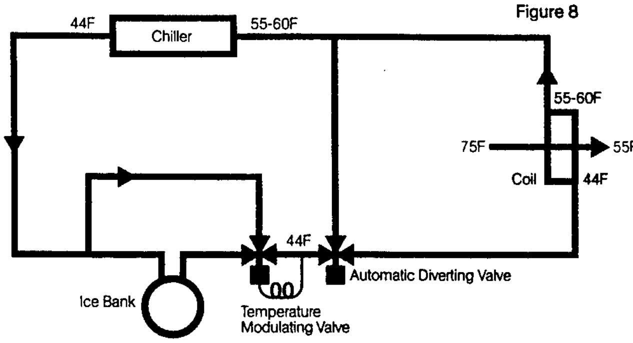


Figure 8



The glycol recommended for the solution is an ethylene glycol-based industrial coolant, such as Dow Chemical Company's Dowtherm® SR-1 or Union Carbide Corporation's UCARTHERM,® which are specially formulated for low viscosity and superior heat transfer properties. These contain a multi-component corrosion inhibitor system which is effective with most materials of construction, including aluminum, copper, solder and plastics. Unlike automotive-type anti-freeze, they produce no films and contain no anti-leak agents to interfere with heat transfer efficiency and permit use of standard system pumps, seals and air handler coils. However, because of the slight difference in heat transfer coefficient between water-glycol and plain water, coil capacity should be increased by approximately 5 percent. It is also important that the water and glycol be thoroughly mixed before the solution enters the system.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5678EC4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ICE STORAGE COOLING SYSTEM
ANALYSIS DATE: 04-18-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	48000.
B. SIOH	$	2640.
C. DESIGN COST	$	2880.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	48168.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	48168.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 3045.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 35474.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 35474.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 0.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 3045.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 35474.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .74
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 15.82

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5678
ENERGY CONSERVATION OPPORTUNITY: ECO–5(A)
SYSTEM MODIFICATION: TWO SPEED FANS FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO–5, install two–speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	6,153	--	21
ECO	--	2,280	--	8
Savings (Baseline–ECO)	0	3,873	0	13

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	13 MMBtu/Yr	X	$4.0141 /MMBtu	=	$53 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$53**	+	**$0**	=	**$53 per year**

NON–ENERGY SAVINGS (+), COST (–):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (–) $0 per year

Total: **$0** – **$0** = **$0 per year**

[ECO–SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input (part 7). The control sequence is:

- 0-50% load, fan 1, half speed cycling.
- 50-100% load, fan 1 full speed cycling.

kWh per bin, for % design loads less than 50% load = (fan 1 power kW) * 14% * (%design load / 50) * 4 hours per bin * days per month.

kWh per bin, for % design loads 50% to 100% load = (fan 1 power kW * ((% design load)/ 100) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 5678	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	77
– WATER FLOW (gpm)	570
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	2365.5
HEAT REJECTION CAPACITY (Btu/min)	47310
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	40.57
TOTAL ENTHALPY	60.57
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	35719
MOTOR DATA	
– FAN 1 POWER (kW)	5.4
– FAN 2 POWER (kW)	0
– FAN 3 POWER (kW)	0
– FAN 4 POWER (kW)	0

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET-BULB AVERAGES (4 hour bins)						DESIGN WB
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	77
MAY	57.1	56.6	61.2	63.9	63	59.4	77
JUNE	66.8	66.6	69.9	71	70.5	68.2	77
JULY	70.8	70.9	74.5	76	74.9	72.6	77
AUGUST	66.9	67	71	72	71	68.5	77
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	77
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	77

ENTHALPY FOR AVERAGE WET-BULBS							DESIGN
	1-4	5-8	9-12	13-16	17-20	21-24	ENTHALPY
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	40.57
MAY	24.53	24.21	27.28	29.23	28.57	26.06	40.57
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	40.57
JULY	34.77	34.86	38.14	39.57	38.52	36.37	40.57
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	40.57
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	40.57
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	40.57

COOLING PROFILE OF CENTRAL PLANTS							PEAK LOAD
	1-4	5-8	9-12	13-16	17-20	21-24	(Btuh)
APRIL	0	0	0	0	0	0	0
MAY	0.3	0.3	0.7	0.7	0.3	0.3	1739000
JUNE	0.3	0.3	0.7	0.7	0.3	0.3	2056000
JULY	0.3	0.3	0.7	0.7	0.3	0.3	2056000
AUGUST	0.3	0.3	0.7	0.7	0.3	0.3	2056000
SEPTEMBER	0.3	0.3	0.7	0.7	0.3	0.3	2056000
OCTOBER	0	0	0	0	0	0	0

RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY							DAYS PER
	1-4	5-8	9-12	13-16	17-20	21-24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	1.8	1.8	1.7	1.6	1.6	1.7	31
JUNE	1.5	1.5	1.3	1.3	1.3	1.4	30
JULY	1.3	1.3	1.1	1.1	1.1	1.2	31
AUGUST	1.5	1.4	1.3	1.2	1.3	1.4	31
SEPTEMBER	1.5	1.5	1.4	1.4	1.4	1.5	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	% DESIGN LOAD						DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	
MAY	14.1	14.0	35.6	37.8	15.9	14.7	31
JUNE	20.6	20.5	52.7	54.6	23.0	21.4	30
JULY	23.3	23.3	62.4	66.7	27.2	24.8	31
AUGUST	20.7	20.7	54.6	56.6	23.4	21.6	31
SEPTEMBER	19.7	19.6	49.4	50.9	20.9	20.0	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	SINGLE SPEED CONTROL (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	94	93	238	253	106	98	
JUNE	134	133	342	354	149	139	
JULY	156	156	418	446	182	166	
AUGUST	138	139	366	379	157	145	
SEPTEMBER	128	127	320	330	136	129	
OCTOBER	0	0	0	0	0	0	
TOTAL	650	648	1684	1763	730	678	6153

	TWO SPEED CONTROL (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	26	26	67	71	30	28	
JUNE	37	37	126	151	42	39	
JULY	44	44	260	317	51	46	
AUGUST	39	39	156	182	44	41	
SEPTEMBER	36	36	90	103	38	36	
OCTOBER	0	0	0	0	0	0	
TOTAL	182	182	698	824	204	190	2280

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO BLDG. 5678	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
2-SPEED COOLING TOWER TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
10 HP 2-SPD MOTOR	1	EA	2.0	2.0	20	39			1358.00	1358.00	$1,397		
2-SPD MOTOR STARTER	1	EA	4.2	4.2	20	82			859.00	859.00	$941		
MOTOR FEEDER	1	LS	4.1	4.1	20	80			20.00	20.00	$100		
REMOVE OLD MOTOR	1	EA	3.3	3.3	20	65					$65		
REMOVE OLD STR	1	EA	4.2	4.2	20	82					$82		
PNEUMATIC THERMOSTAT	2	EA	1.0	2.0	20	39			34.12	68.24	$107		
SUBTOTAL						$388				$2,305	$2,693		
OVERHEAD, BOND	16%					$62				$369	$431		
PROFIT	10%					$39				$231	$269		
COST SUB-TOTAL						$489				$2,905	$3,394		
CONTINGENCY	20%					$98				$581	$679		
SUBTOTAL						$587				$3,486	$4,072		
S&A	5.5%					$32				$192	$224		
TOTAL THIS SHEET						$619				$3,677	$4,296		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5678EC5A
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	4072.
B. SIOH	$	224.
C. DESIGN COST	$	245.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	4087.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	4087.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	13.	$ 53.	11.37	603.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		13.	$ 53.		$ 603.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 199.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 53.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 603.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .15
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 77.02

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5678
ENERGY CONSERVATION OPPORTUNITY: ECO– 5(B)
SYSTEM MODIFICATION: VARIABLE SPEED DRIVE FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO–5, install two–speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

	Electric		Nat. Gas	Total Energy
PC CUBE RUN	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	––	6,153	––	21
ECO	––	1,432	––	5
Savings (Baseline–ECO)	0	4,721	0	16

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 16 MMBtu/Yr X $4.0141 /MMBtu = $65 per year

Nat. Gas: 0 MMBtu/Yr X $2.92 /MMBtu = $0 per year

Total Energy Cost Savings: $65 + $0 = $65 per year

NON–ENERGY SAVINGS (+), COST (–):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (–) $289 per year

Total: $0 – $289 = ($289) per year

[ECO–SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input (part 7). The control sequence is:

- 0-50% load, fan 1, half speed cycling.
- 50-100% load, fan 1 full speed cycling.

kWh per bin, for % design loads less than 50% load = (fan 1 power kW) * 14% * (%design load / 50) * 4 hours per bin * days per month.

kWh per bin, for % design loads 50% to 100% load = (fan 1 power kW * ((% design load)/ 100) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 5678	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	77
– WATER FLOW (gpm)	570
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	2365.5
HEAT REJECTION CAPACITY (Btu/min)	47310
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	40.57
TOTAL ENTHALPY	60.57
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	35719
MOTOR DATA	
– FAN 1 POWER (kW)	5.4
– FAN 2 POWER (kW)	0
– FAN 3 POWER (kW)	0
– FAN 4 POWER (kW)	0

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET-BULB AVERAGES (4 hour bins)						DESIGN
	1–4	5–8	9–12	13–16	17–20	21–24	WB
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	77
MAY	57.1	56.6	61.2	63.9	63	59.4	77
JUNE	66.8	66.6	69.9	71	70.5	68.2	77
JULY	70.8	70.9	74.5	76	74.9	72.6	77
AUGUST	66.9	67	71	72	71	68.5	77
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	77
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	77

ENTHALPY FOR AVERAGE WET-BULBS	1-4	5-8	9-12	13-16	17-20	21-24	DESIGN ENTHALPY
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	40.57
MAY	24.53	24.21	27.28	29.23	28.57	26.06	40.57
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	40.57
JULY	34.77	34.86	38.14	39.57	38.52	36.37	40.57
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	40.57
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	40.57
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	40.57

COOLING PROFILE OF CENTRAL PLANTS	1-4	5-8	9-12	13-16	17-20	21-24	PEAK LOAD (Btuh)
APRIL	0	0	0	0	0	0	0
MAY	0.3	0.3	0.7	0.7	0.3	0.3	1739000
JUNE	0.3	0.3	0.7	0.7	0.3	0.3	2056000
JULY	0.3	0.3	0.7	0.7	0.3	0.3	2056000
AUGUST	0.3	0.3	0.7	0.7	0.3	0.3	2056000
SEPTEMBER	0.3	0.3	0.7	0.7	0.3	0.3	2056000
OCTOBER	0	0	0	0	0	0	0

RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY	1-4	5-8	9-12	13-16	17-20	21-24	DAYS PER MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	1.8	1.8	1.7	1.6	1.6	1.7	31
JUNE	1.5	1.5	1.3	1.3	1.3	1.4	30
JULY	1.3	1.3	1.1	1.1	1.1	1.2	31
AUGUST	1.5	1.4	1.3	1.2	1.3	1.4	31
SEPTEMBER	1.5	1.5	1.4	1.4	1.4	1.5	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	% DESIGN LOAD						DAYS PER
	1−4	5−8	9−12	13−16	17−20	21−24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	
MAY	14.1	14.0	35.6	37.8	15.9	14.7	31
JUNE	20.6	20.5	52.7	54.6	23.0	21.4	30
JULY	23.3	23.3	62.4	66.7	27.2	24.8	31
AUGUST	20.7	20.7	54.6	56.6	23.4	21.6	31
SEPTEMBER	19.7	19.6	49.4	50.9	20.9	20.0	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	SINGLE SPEED CONTROL (kWh)						TOTAL
	1−4	5−8	9−12	13−16	17−20	21−24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	94	93	238	253	106	98	
JUNE	134	133	342	354	149	139	
JULY	156	156	418	446	182	166	
AUGUST	138	139	366	379	157	145	
SEPTEMBER	128	127	320	330	136	129	
OCTOBER	0	0	0	0	0	0	
TOTAL	650	648	1684	1763	730	678	6153

	TWO SPEED CONTROL (kWh)						TOTAL
	1−4	5−8	9−12	13−16	17−20	21−24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	26	26	67	71	30	28	
JUNE	37	37	126	151	42	39	
JULY	44	44	260	317	51	46	
AUGUST	39	39	156	182	44	41	
SEPTEMBER	36	36	90	103	38	36	
OCTOBER	0	0	0	0	0	0	
TOTAL	182	182	698	824	204	190	2280

	VARIABLE SPEED COOLING TOWER CYCLING (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	2	2	38	45	3	3	
JUNE	7	7	119	132	10	8	
JULY	11	11	204	248	17	13	
AUGUST	7	7	137	152	11	8	
SEPTEMBER	6	6	98	107	7	6	
OCTOBER	0	0	0	0	0	0	
TOTAL	34	33	594	684	48	38	1432

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [ ] CODE B [X] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO BLDG. 5678 / VARIABLE SPEED COOLING TOWER	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
VFD FOR ONE 10 HP MOTOR	1	EA	4.0	4.0	20	78			2500.00	2500.00	$2,578		
VFD WIRING & CONNECTION	1	LS	4.1	4.1	20	80			20.00	20.00	$100		
WATER TEMPERATURE SENSOR	1	EA	9.0	9.0	20	176			328.00	328.00	$504		
SUBTOTAL						$334				$2,848	$3,182		
OVERHEAD, BOND	16%					$53				$456	$509		
PROFIT	10%					$33				$285	$318		
COST SUB-TOTAL						$421				$3,588	$4,010		
CONTINGENCY	20%					$84				$718	$802		
SUBTOTAL						$505				$4,306	$4,811		
S&A	5.5%					$28				$237	$265		
TOTA[illegible]IS SHEET						$533				$4,543	$5,076		

DA FOR[illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
STUDY: 5678EC5B
LCCID 1.035

INSTALLATION & LOCATION: FT. SILL, OKLAHOMA   REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000   ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991   DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91   ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	4811.
B. SIOH	$	265.
C. DESIGN COST	$	289.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	4829.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	4829.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	16.	$ 65.	11.37	735.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		16.	$ 65.		$ 735.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -289.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -3367.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -3367.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 243.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -224.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -2632.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.55
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -21.52

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5678
ENERGY CONSERVATION OPPORTUNITY: ECO-6
SYSTEM MODIFICATION: HIGH EFFICIENCY MOTOR REPLACEMENT
SYSTEMS TO MODIFY: PUMP & COOLING TOWER MOTORS

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-6, install high efficiency motors.
It was estimated that the electrical energy can be saved by installing high efficiency motors based on the motor operating hours per year.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	3	14,412	0	49

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	49 MMBtu/Yr	X	$4.0141 /MMBtu	=	$197 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$197**	+	**$0**	=	**$197 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 3 kW/month X $1.787 /kW X 12 months/year

= (+) $64 per year

Maintenance: = (-) $0 per year

Total: **$64** - **$0** = **$64 per year**

[ECO-SHT.WK3]

HIGH EFFICIENCY
MOTOR REPLACEMENT

LABOR RATE:	19.6	$/hr
ELECTRIC CONS.	0.0137	$/kWH
ELECTRIC DEMAND	1.787	$/kW

BLDG. NO.	EQUIPMENT SERVE	MOTOR HP	MOTOR FLA	MEAS AMPS	MEAS PF	MEAS VOLT	EXST EFF	NEW EFF	KW SVGS	HRS/ YEAR	KWH/YR SVGS	SVGS/ YEAR
730	CWP-1	150.0	179.0	147.0	0.87	460	90.19%	95.00%	5.73	2641	15120	$330
	CWP-2	150.0	179.0	148.0	0.91	460	86.22%	95.00%	11.50	1873	21539	$542
	CNWP-1	50.0	118.0	107.0	0.98	230	80.97%	93.00%	6.67	2641	17629	$385
	CNWP-2	50.0	118.0	107.0	0.99	230	80.15%	93.00%	7.27	468	3405	$203
	CNWP-3	NI	NI	NI								
	CTM-1	30.0	71.4	70.7	0.93	230	84.60%	92.40%	2.61	702	1834	$81
	CTM-2	30.0	71.4	71.0	0.87	230	90.44%	92.40%	0.58	702	405	$18
	HWP-1	50.0	125.0	117.5	0.87	230	86.10%	93.00%	3.51	3624	12722	$250
	HWP-2	50.0	125.0	118.0	0.87	230	86.10%	93.00%	3.53	3624	12776	$251
		DEMAND CREDIT		**$888**	**MMBtu**	**292**		**TOTAL**	**41**		**85430**	**$2,058**
914	CWP-1	40.0	48.0	41.3	0.87	460	89.69%	93.00%	1.14	3672	4178	$82
	CNWP-1	15.0	19.0	14.4	0.82	460	90.15%	90.20%	0.01	3672	23	$0
	CTM-1	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	CTM-2	10.0	15.0	12.0	0.82	460	76.12%	89.50%	1.54	416	640	$42
	HWP-1	2.0	6.2	5.4	0.87	230	69.43%	84.00%	0.47	3624	1694	$33
	HWP-2	2.0	6.2	5.6	0.87	230	69.43%	84.00%	0.48	3624	1757	$34
		DEMAND CREDIT		**$111**	**MMBtu**	**30**		**TOTAL**	**5**		**8932**	**$233**
2812	CWP-1	20.0	27.0	23.0	0.77	460	90.07%	91.00%	0.16	3672	586	$11
	CNWP-1	25.0	31.5	26.5	0.82	460	91.18%	91.70%	0.11	3672	394	$8
	CTM-1	15.0	18.6	18.6	0.87	460	86.79%	90.20%	0.56	1167	655	$21
	HWP-1	7.5	21.6	18.5	0.87	230	74.74%	88.50%	1.33	5163	6888	$123
	HWP-2	7.5	21.6	19.0	0.87	230	74.74%	88.50%	1.37	3672	5031	$98
		DEMAND CREDIT		**$76**	**MMBtu**	**46**		**TOTAL**	**4**		**13554**	**$261**
3442	CWP-1	60.0	73.0	63.0	0.84	460	91.62%	94.50%	1.40	3672	5158	$101
	CWP-2	60.0	73.0	63.4	0.84	460	91.62%	94.50%	1.41	3672	5191	$101
	CNWP-1	40.0	52.0	41.0	0.78	460	92.34%	93.00%	0.20	3672	721	$14
	CNWP-2	40.0	52.0	35.8	0.78	460	92.34%	93.00%	0.17	3672	629	$12
	CTM-1	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-2	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-3	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
	CTM-4	15.0	18.3	14.6	0.87	460	88.21%	90.20%	0.25	1169	295	$9
		DEMAND CREDIT		**$90**	**MMBtu**	**44**		**TOTAL**	**4**		**12880**	**$266**
4701	CWP-1	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CWP-2	50.0	60.7	51	0.87	440	92.68%	93.00%	0.13	1873	235	$6
	CNWP-1	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CNWP-2	30.0	38	33	0.87	440	88.83%	92.40%	0.95	1873	1784	$45
	CTM-1	20.0	24.6	18.2	0.87	460	87.50%	91.00%	0.55	650	361	$17
	CTM-2	15.0	19.2	16.5	0.87	440	87.90%	90.20%	0.32	650	206	$10
		DEMAND CREDIT		**$65**	**MMBtu**	**16**		**TOTAL**	**3**		**4605**	**$128**
5676	HCP-1	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	HCP-2	10.0	13.5	13	0.87	460	79.72%	89.50%	1.24	7296	9012	$150
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	10.5	9	0.79	460	84.66%	88.50%	0.29	1160	337	$11
		DEMAND CREDIT		**$94**	**MMBtu**	**83**		**TOTAL**	**4**		**24287**	**$427**
5678	HCP-1	2.0	6.5	5.9	0.83	208	76.76%	84.00%	0.20	7296	1445	$24
	HCP-2	2.0	6.5	5.7	0.83	208	76.76%	84.00%	0.19	7296	1396	$23
	HCP-3	1.5	4.8	4.5	0.83	230	70.51%	84.00%	0.34	7296	2474	$41
	HCP-4	2.0	6.3	5.8	0.83	230	71.62%	84.00%	0.39	7296	2878	$48
	CNWP-1	7.5	11	10	0.87	460	73.38%	88.50%	1.61	3672	5927	$116
	CTM-1	7.5	11	9.6	0.75	460	85.12%	88.50%	0.26	1139	293	$10
		DEMAND CREDIT		**$64**	**MMBtu**	**49**		**TOTAL**	**3**		**14412**	**$262**

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 10-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

MOTOR REP. ECO BLDG. 5678	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
HIGH EFF. MOTOR REP.LACEMENT TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
HCP-1 2.0 HP MOTOR	1	EA	3.2	3.2	20	63			359.0	359.00	$422		
HCP-2 2.0 HP MOTOR	1	EA	3.2	3.2	20	63			359.0	359.00	$422		
HCP-3 1.5 HP MOTOR	1	EA	3.2	3.2	20	63			328.0	328.00	$391		
HCP-4 2.0 HP MOTOR	1	EA	3.2	3.2	20	63			359.0	359.00	$422		
CNWP-1 7.5 HP MOTOR	1	EA	3.4	3.4	20	67			616.0	616.00	$683		
CTM-1 7.5 HP MOTOR	1	EA	3.4	3.4	20	67			616.0	616.00	$683		
SUBTOTAL						$385				$2,637	$3,022		
OVERHEAD, BOND	16%					$62				$422	$484		
PROFIT	10%					$39				$264	$302		
COST SUB-TOTAL						$485				$3,323	$3,808		
CONTINGENCY	20%					$97				$665	$762		
SUBTOTAL						$583				$3,987	$4,570		
S&A	5.5%					$32				$219	$251		
TOTAL THIS SHEET						$615				$4,206	$4,821		

DA FOR[illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5678EC6
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: HIGH EFF. MOTOR
ANALYSIS DATE: 04-10-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	4570.
B. SIOH	$	252.
C. DESIGN COST	$	275.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	4587.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	4587.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	49.	$ 197.	11.37	2245.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		49.	$ 197.		$ 2245.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 64.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 746.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 746.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 741.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .65
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 261.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2991.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .65
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 17.54

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5678
ENERGY CONSERVATION OPPORTUNITY: ECO-7
SYSTEM MODIFICATION: INSTALL INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-7, install instrumentation to facilitate efficient operation of boiler plant. It was estimated that the energy wasted from boiler in standby is 1% of the rated output capacity. The hours when boilers are running unnecessary were estimated for each boiler.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	0	0	11	11

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 0 MMBtu/Yr X $4.0141 /MMBtu = $0 per year

Nat. Gas: 11 MMBtu/Yr X $2.92 /MMBtu = $32 per year

Total Energy Cost Savings: $0 + $32 = $32 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $320 per year

Total: $0 - $320 = ($320) per year

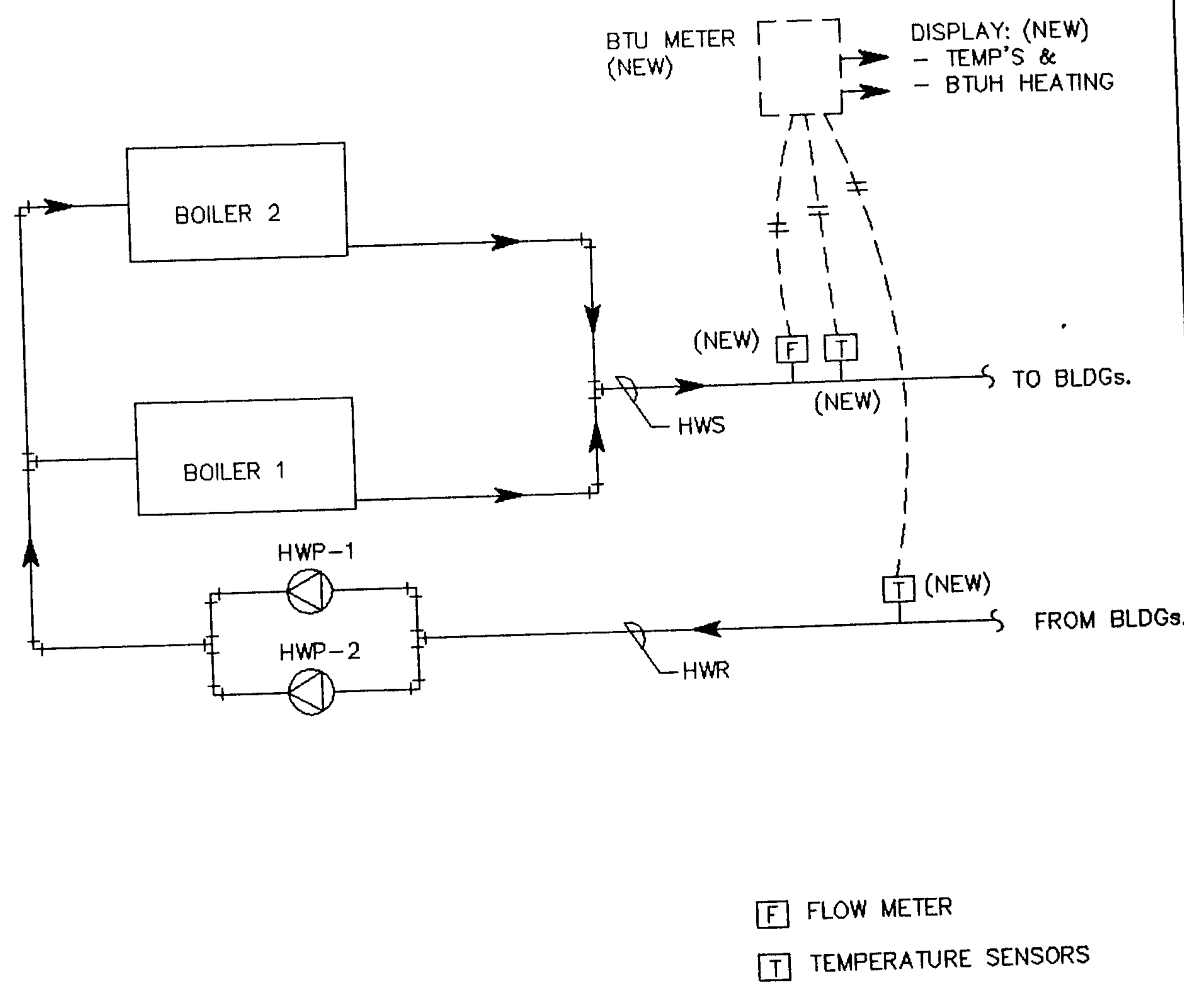
[ECO-SHT.WK3]

BOILER STANDBY SAVINGS

CENTRAL PLANT	BOILER NO.	BOILER TYPE	BOILER MANUFACTURERER	BOILER MODEL NUMBER	RATED BOILER OUTPUT MMBTU/H	CALC. BOILER OUTPUT MMBTU/H	STANDBY LOSS (1%) MMBTU/H	EXCESS STANDBY (HRS/YR)	EXCESS STANDBY MMBTU/H	EXCESS STANDBY SAVINGS ($)
5900	1	HTHW	INTERNATIONAL	D-12	10.00	6.94	0.0694	0		
	2	HTHW	INTERNATIONAL	D-12	10.00	7.17	0.0717	720	51.62	$150.74
	3	HTHW	HERCULES	300	9.70	7.61	0.0761	720	54.82	$160.09
	4	HTHW	HERCULES	300	9.70	7.58	0.0758	720	54.55	$159.27
	5	HTHW	INTERNATIONAL	1035 TH12	8.00	6.22	0.0622	0		
	6	HTHW	INTERNATIONAL	TJW-C-10	11.20	8.88	0.0888	0		
						TOTAL		2160	160.99	$470.10
6003	1	STEAM-12	KEWANEE	L39-350-605	11.72	9.41	0.0941	0		
	2	STEAM-12	YORK SHIPLEY	SPL-350-112080	11.72	9.12	0.0912	0		
	3	STEAM-12	KEWANEE	L36-350-605	11.72	9.37	0.0937	720	67.45	$196.96
						TOTAL		720	67.45	$196.96
730	1	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	0		
	2	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	720	44.34	$129.47
	3	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.18	0.0618	720	44.51	$129.96
	4	STEAM-12	KEWANEE	CAT#7L280-KG-06	2.66	2.11	0.0211	0		
						TOTAL		1440	88.84	$259.43
2812	1	STEAM-12	FEDERAL BOILER CO	GS 3562	1.80	1.40	0.0140	0		
	2	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.77	0.0277	0		
	3	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.86	0.0286	720	20.62	$60.21
						TOTAL		720	20.62	$60.21
5676	1	HW	AMERICAN STANDARD	PF 515	2.44	1.80	0.0180	720	12.93	$37.76
	2	HW	AMERICAN STANDARD	PF 515	2.44	1.71	0.0171	0		
						TOTAL		720	12.93	$37.76
5678	1	HW	BRUNHAM	PF 514	2.27	1.50	0.0150	720	10.79	$31.50
	2	HW	BRUNHAM	PF 514	2.27	1.63	0.0163	0		
						TOTAL		720	10.79	$31.50
914	1	STEAM-12	BRUNHAM	PF-510	1.61	1.29	0.0129	0		
	2	HW	RAY-PAK	EA 200ITB	1.61	1.22	0.0122	0		
	3	HW	AMERICAN STANDARD	G1015	1.92	1.47	0.0147	720	10.56	$30.84
	4	HW	AMERICAN STANDARD	G1015	1.92	1.40	0.0140	0		
						TOTAL		720	10.56	$30.84
4701	1	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	0		
	2	STEAM-100	BIRCHFIELD	FBH 578	11.00	0.00	0.0000	0		
	3	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	720	60.73	$177.33
						TOTAL		720	60.73	$177.33

[BOILERS.WK3]

ECO-7, INSTRUMENTATION FOR BOILER PLANT
(TYPICAL)



[B-ECO-7.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO BLDG. 5678	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
INSTRUMENTATION / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 2 HW BOILERS													
HWS TEMPERATURE SENSOR	1	EA			176	176			328.00	328.00	$504		
HWR TEMPERATURE SENSOR	1	EA			176	176			328.00	328.00	$504		
INSERT. FLOW METER	1	EA			197	197			764.00	764.00	$961		
BTU METER	1	EA	6.0	6.0	20	118			820.00	820.00	$938		
LED DISPLAY	2	EA							60.00	120.00	$120		
LED INSTALLATION	2	EA	4.6	9.2	19.6	180			158	316	496.32		
SUBTOTAL						$847				$2,676	$3,523		
OVERHEAD, BOND	16%					$136				$428	$564		
PROFIT	10%					$85				$268	$352		
COST SUB-TOTAL						$1,067				$3,372	$4,439		
CONTINGENCY	20%					$213				$674	$888		
SUBTOTAL						$1,281				$4,046	$5,327		
S&A	5.5%					$70				$223	$293		
TOTAL THIS SHEET						$1,351				$4,269	$5,620		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: B5678E12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER INSTRUMENTATION
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	5327.
B. SIOH	$	293.
C. DESIGN COST	$	320.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	5346.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	5346.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	11.	$ 32.	12.48	393.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		11.	$ 32.		$ 393.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -320.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -2915.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -2915.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 130.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -288.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -2522.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.47
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -18.53

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5678
ENERGY CONSERVATION OPPORTUNITY: ECO-8
SYSTEM MODIFICATION: BOILER OPTIMIZATION, CONTROL & INSTRUMENTATION
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-8, install instrumentation connected to EMCS for boiler optimization.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	16,330	16,330
ECO	--	--	16,058	16,058
Savings (Baseline-ECO)	0	0	272	272

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	272 MMBtu/Yr	X	$2.92 /MMBtu	=	$794 per year
Total Energy Cost Savings:	**$0**	+	**$794**	=	**$794 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $1,632 per year

Total: **$0** - **$1,632** = **($1,632) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	16330.
PEAK DAY GAS CONSUMP., 1000 CU FT	136.
ELECTRICAL CONSUMPTION, KWH	233241.
PEAK KW DEMAND (15 MIN BASIS)	106.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	233241.
ON-PEAK KW DEMAND (15 MIN BASIS)	106.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2808
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

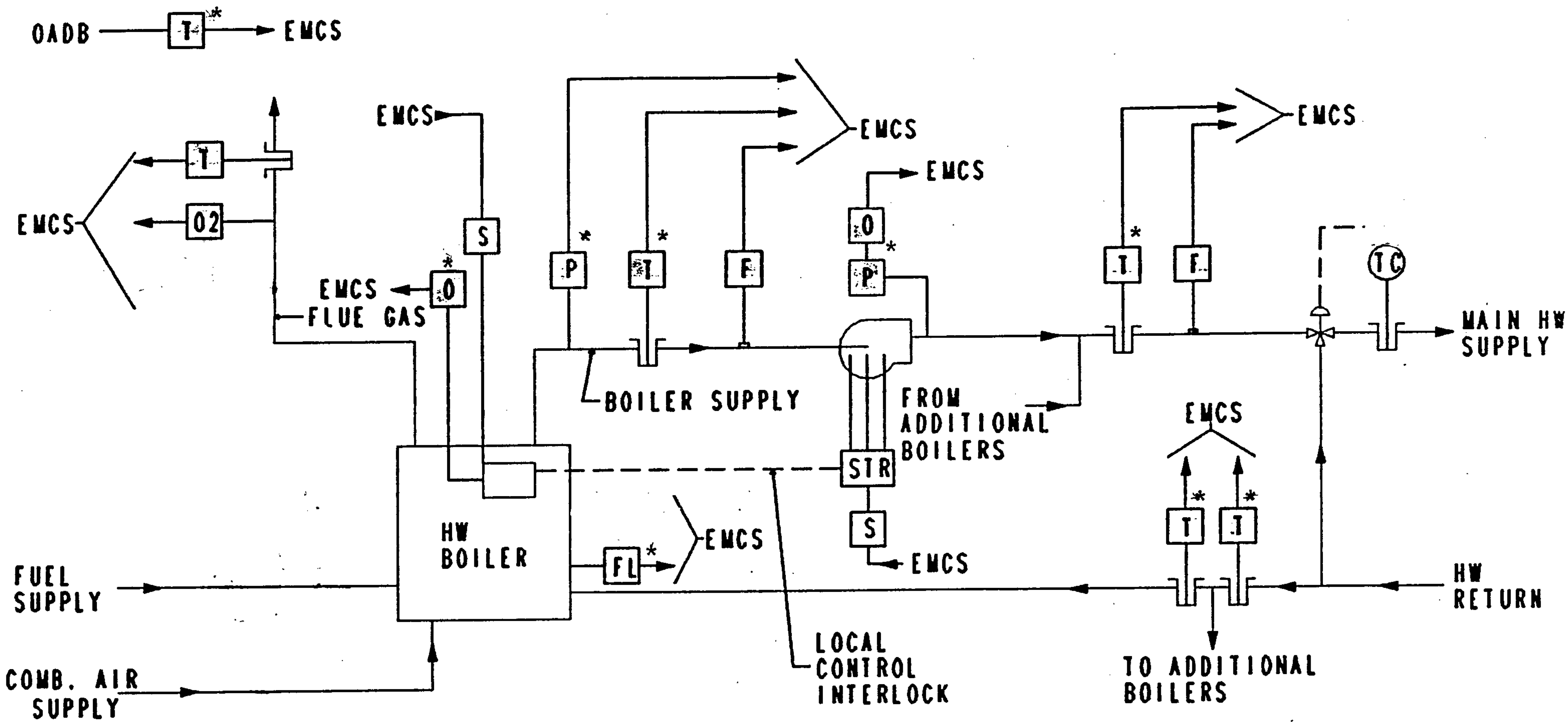
PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BOILER ECO-2

** TOTAL **

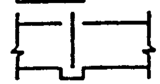
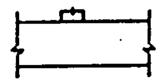
SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	16057.
PEAK DAY GAS CONSUMP., 1000 CU FT	136.
ELECTRICAL CONSUMPTION, KWH	233241.
PEAK KW DEMAND (15 MIN BASIS)	106.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	233241.
ON-PEAK KW DEMAND (15 MIN BASIS)	106.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2767
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.



Hot water boiler

* - Points included on proposed EMCS design, existing.
All other points are new.

Symbol	Meaning
→ EMCS	SIGNAL TRANSMITTED TO EMCS
← EMCS	SIGNAL TRANSMITTED FROM EMCS
A	ALARM CONTACT SIGNAL
E	ECONOMIZER CONTROL INTERFACE
F	FLOW INDICATION
FL	FLAME INDICATION
H	HUMIDITY INDICATION
P	PRESSURE INDICATION
LV	LEVEL INDICATION
M	METER
O	ON-OFF STATUS SIGNAL
DP	DIFFERENTIAL PRESSURE SWITCH
R	CONTROLLER RESET INTERFACE
S	START-STOP INTERFACE
T	TEMPERATURE INDICATION
V	VENTILATION/RECIRCULATION CONTROL
PS	POSITION
O_2	FLUE GAS ANALYSIS, OXYGEN
Co	FLUE GAS ANALYSIS, CARBON MONOXIDE
FD	FURNACE DRAFT DIFFERENTIAL PRESSURE
DS	HIGH-LOW DEMAND SIGNAL SELECTOR
TC	TEMPERATURE CONTROLLER
PC	PRESSURE CONTROLLER
STR	MOTOR STARTER
	SENSOR INSTALLED IN THERMOMETER WELL
	SENSOR INSTALLED IN DUCT OR PLENUM
CHW	CHILLED WATER
EA	EXHAUST AIR
SA	SUPPLY AIR
RA	RETURN AIR
OA	OUTSIDE AIR
MA	MIXED AIR
WB	WET BULB
DB	DRY BULB
OAD	OUTSIDE AIR DAMPER
RAD	RETURN AIR DAMPER
EAD	EXHAUST AIR DAMPER
MZD	MULTIZONE DAMPER
RH	RELATIVE HUMIDITY

Symbols and Abbreviations

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 12-Apr-91

DRAWING NO.

SHT OF

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO BLDG. 5678 / OPTIMIZE BOILER SEQUENCE	Quantity			LABOR			EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 2 HW BOILERS													
HWS TEMPERATURE SENSOR	2	EA			176	$352			$328	$656	$1,008		
HWR TEMPERATURE SENSOR	2	EA			176	$352			$328	$656	$1,008		
HWP ST/SP	4	LS			39	$157			$226	$904	$1,061		
DP (LIQUID) PUMP STATUS	4	LS			155	$620			$205	$820	$1,440		
BOILER ST/SP	1	EA	2.0	2.0	20	$39			$226	$226	$265		
FID PANEL & ACCESSORIES *	1	LS			208	$208			$3,681	$3,681	$7,570		
FID SOFTWARE COMMISSIONING	1	EA	6.0	6.0	45	$270					$270		
FID TESTING	1	EA	6	6	45	270					$270		
INST. FLOW METER	1	EA	3.5	3.5	20	$69			500	$500	$569		
STACK O2 SENSOR	2	LS			338	$676			$3,483	$6,966	$7,642		
STACK TEMP. SENSOR	2	EA	4.0	8.0	20	$157			$207	$413	$570		
CREDIT FROM EMCS PROJECT *						($208)				($3,681)	($3,889)		
SUBTOTAL						$3,169				$14,822	$17,991		
OVERHEAD, BOND	16.0%					$507				$2,372	$2,879		
PROFIT	10.0%					$317				$1,482	$1,799		
COST SUB-TOTAL						$3,993				$18,676	$22,669		
CONTINGENCY	20.0%					$799				$3,735	$4,534		
SUBTOTAL						$4,792				$22,411	$27,203		
S&A	5.5%					$264				$1,233	$1,496		
TOTA[illegible]S SHEET						$5,056				$23,643	$28,699		

DA FORM [illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY　　STUDY: B5678E12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)　　LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA　　REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000　ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991　DISCRETE PORTION NAME: BOILER OPTIMIZATION
ANALYSIS DATE: 04-12-91　ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	27203.
B. SIOH	$	1497.
C. DESIGN COST	$	1633.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	27300.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	27300.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	272.	$ 794.	12.48	9912.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		272.	$ 794.		$ 9912.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)　　$ -1632.
(1) DISCOUNT FACTOR (TABLE A)　　9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1)　　$ -14868.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -14868.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33)　　$ 3271.
A IF 3D1 IS = OR > 3C　GO TO ITEM 4
B IF 3D1 IS < 3C　CALC　SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1　GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -838.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C)　　$ -4955.

6. DISCOUNTED SAVINGS RATIO　　(SIR)=(5 / 1F)= -.18
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED)　SPB=1F/4　　-32.59

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5678
ENERGY CONSERVATION OPPORTUNITY: ECO-9
SYSTEM MODIFICATION: REPLACE BOILER WITH HIGHER EFFICIENCY BOILER
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-9, renovate or replace existing boilers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	16,330	16,330
ECO	--	--	11,200	11,200
Savings (Baseline-ECO)	0	0	5,130	5,130

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	5130 MMBtu/Yr	X	$2.92 /MMBtu	=	$14,980 per year
Total Energy Cost Savings:	**$0**	+	**$14,980**	=	**$14,980 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $3,000 per year

Total: **$0** - **$3,000** = **($3,000) per year**

[ECO-SHT.WK3]

CENTRAL PLANT 5678 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	16330.
PEAK DAY GAS CONSUMP., 1000 CU FT	136.
ELECTRICAL CONSUMPTION, KWH	233241.
PEAK KW DEMAND (15 MIN BASIS)	106.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	233241.
ON-PEAK KW DEMAND (15 MIN BASIS)	106.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2808
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BOILER ECO-3

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	11199.
PEAK DAY GAS CONSUMP., 1000 CU FT	116.
ELECTRICAL CONSUMPTION, KWH	233241.
PEAK KW DEMAND (15 MIN BASIS)	106.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	233241.
ON-PEAK KW DEMAND (15 MIN BASIS)	106.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	1960
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CODE A [X] CODE B [ ] CODE C

OTHER ______

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO BLDG. 5678	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
BOILER REPLACEMENT TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
REPLACEMENT OF BOILER 1 AND 2													
2.6 MMBtu GAS FIRED BOILER	2	EA	100.0	200.0	24	$4,800			$29,900	$59,800	$64,600		
REMOVE OF EXISTING BOILERS	2	EA	30.0	60.0	24	$1,440					$1,440		
SUBTOTAL						$6,240				$59,800	$66,040		
OVERHEAD, BOND	16.0%					$998				$9,568	$10,566		
PROFIT	10.0%					$624				$5,980	$6,604		
COST SUB-TOTAL						$7,862				$75,348	$83,210		
CONTINGENCY	20.0%					$1,572				$15,070	$16,642		
SUBTOTAL						$9,435				$90,418	$99,852		
S&A	5.5%					$519				$4,973	$5,492		
TOTAL THIS SHEET						$9,954				$95,391	$105,344		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY　　STUDY: B5678EC3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)　　LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA　　REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000　ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991　DISCRETE PORTION NAME: BOILER REPLACEMENT
ANALYSIS DATE: 04-12-91　ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	99852.
B. SIOH	$	5492.
C. DESIGN COST	$	5992.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	100202.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	100202.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	5130.	$ 14980.	17.52	262443.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		5130.	$ 14980.		$ 262443.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)　　$ -1792.
(1) DISCOUNT FACTOR (TABLE A)　　11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1)　　$ -20877.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -20877.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33)　　$ 86606.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 13188.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C)　　$ 241566.

6. DISCOUNTED SAVINGS RATIO　　(SIR)=(5 / 1F)= 2.41
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED)　SPB=1F/4　　7.60

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5678
ENERGY CONSERVATION OPPORTUNITY: ECO-10
SYSTEM MODIFICATION: OXYGEN TRIM FOR BURNERS
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-10, install oxygen trim for burners.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	16,330	16,330
ECO	--	--	14,793	14,793
Savings (Baseline-ECO)	0	0	1,537	1,537

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 0 MMBtu/Yr X $4.0141 /MMBtu = $0 per year

Nat. Gas: 1537 MMBtu/Yr X $2.92 /MMBtu = $4,488 per year

Total Energy Cost Savings: $0 + $4,488 = $4,488 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year
= (+) $0 per year

Maintenance: = (-) $1,799 per year

Total: $0 - $1,799 = ($1,799) per year

[ECO-SHT.WK3]

CENTRAL PLANT 5678 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	16330.
PEAK DAY GAS CONSUMP., 1000 CU FT	136.
ELECTRICAL CONSUMPTION, KWH	233241.
PEAK KW DEMAND (15 MIN BASIS)	106.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	233241.
ON-PEAK KW DEMAND (15 MIN BASIS)	106.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2808
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BOILER ECO-4

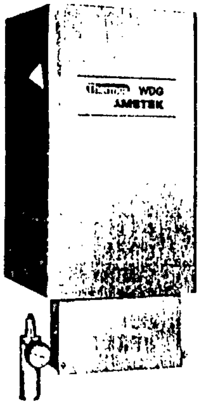
** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	14792.
PEAK DAY GAS CONSUMP., 1000 CU FT	136.
ELECTRICAL CONSUMPTION, KWH	233241.
PEAK KW DEMAND (15 MIN BASIS)	106.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	233241.
ON-PEAK KW DEMAND (15 MIN BASIS)	106.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2637
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

SPECIFICATIONS – AIR-MIZER II SYSTEM

SENSOR



Nominal Dimensions: 14⅝"H x 10¼"W x 10"D (37.2 x 26 x 25.4 cm)

Enclosure: Weather resistant—S.S. case, nickel plated carbon steel base

Weight: 55 pounds (25 kg)

Accuracy: ±1% of net excess oxygen

Repeatability: ±0.2% of measured value

Response: 90% of full scale in less than 5 seconds

Drift: Less than 0.1% of sensor cell output per month

Ambient Temperatures: −5 to +175°F (−20.5 to +79°C)

Sample Temperatures: Up to 1300°F (704°C) with standard probe

Sample Flow Rate: 0.1 to 120 scfh (0.47 to 56.65 liters/minute)

Air Aspirator Requirements: 10 to 20 scfh (4.72 to 14.16 liters/ min) at 15-100 psi (1.05 to 7.037 kg/cm²) (Aspirator air regulator furnished with sensor normally set at 2-7 psi; 0.14 - 0.49 kg/cm²)

Calibration: With analyzed oxygen in nitrogen sample. Calibration port provided.

CONTROL UNIT

Nominal Dimensions: 12⅝"H x 10⅞"W x 9⅛"D (32.1 x 27.6 x 23.2 cm)

Enclosure: Wall/panel mounted—meets the requirements for NEMA 4 areas

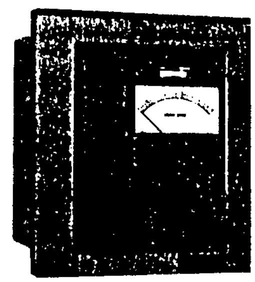
Weight: 22 pounds (10 kg)

Temperature Control: On-Off by microprocessor (±1°C)

Linearization: 256 segments from 20% to 0.2% O_2, (218 from 10% to 0.2%), by microprocessor

Controller Action: On-Off—"On" time adjustable 2-20 seconds. "Off" time adjustable 2-60 seconds.
Deadband: ± 0.25% oxygen.
LED's indicate motor driving.
Will not allow decrease in air when O_2 is below 0.5% oxygen. Air flow will increase to +15% max. If O_2 level is above 12%.

Setpoint: 0 to 10% oxygen by either of: A. Two banks of 5 slide pots, (Dual Fuel) selectable by slide switch; proper pot or pots connected to processor by switch in actuator. B. Manual pot on panel A or B selected by Remote/Local switch on panel. Setpoint indicated by edge reading meter (0-10%)



Manual Control: Manual/Auto switch and increase—decrease push buttons (Spring return switch inside control unit can override all control actions in the event of processor failure).

Ready Indicator: On at temperature set point. Off below temperature set point. Flashes above temperature set point. O_2 Control in "manual" when below set point.

Oxygen Scale: 20.9 to 0.1% O_2 Logarithmic

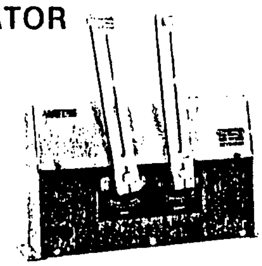
Alarms: High and Low O_2 adjustable 0.2 to 20%. RTD Failure (shuts down temperature control, and puts O_2 control in "manual").

Increase Air Override: Contact closure from optional combustibles or smoke detector alarm will cause increase in air signal on each control pulse regardless or O_2 vs. O_2 setpoint relationship. Once combustibles contact opens, normal control will resume. This maintains air flow at a level where maximum allowable combustibles or smoke is not exceeded.

Ambient Temperature Limits: 32°F to 140°F (0 to +60°C)

Recorder Output: 0-100 mv = 0-20% O_2 Linear (0-50 mv = 0-10%) Other current or voltages outputs optional

ACTUATOR



Overall Size: 17½"L x 4"W x 10¼"H (44.5 x 10.2 x 26 cm)

Weight: 16.5 pounds (7.5 kg)

Angular Travel (Input Arm): 60°

Linear Link Travel: Adjustable 4" to 10" at 4" to 10" Radius (10.2 to 25.4 cm at 10.2 to 25.4 cm Radius)

Linear Link Force: 100 pounds at 4" Radius (45.5 kg at 10.2 cm Radius)
70 pounds at 6" Radius (31.8 kg at 15.2 cm Radius)
40 pounds at 10" Radius (18.2 kg at 25.4 cm Radius)

Case: Suitable for areas requiring NEMA 2 equipment (Drip proof indoor)

Correction: −15% to +15% (.85 to 1.15 gain) of normal air flow

Speed: 60 seconds from −15% to +15% correction (max.)

Load Indication: 9 position shorting switch tied to input arm

Brake: Internal brake will hold load at any above rated force without "coasting"

Ambient Temperature Limits: 0°F to 160°F (−18 to +71°C)

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C

[ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO BLDG. 5678	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
BOILER CONTROL O2 TRIM / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
O2 TRIM CONTROL	2	EA			3000	$6,000			$1,800	$9,590	$15,590		
ANNUAL RECURRING COST													
OXYGEN SENSOR	2	EA	0.5	1.0	24	$24			$420	$840	$864		
OTHER MAINTENANCE COST	1	LS							$935	$935	$935		
ANNUAL TOTAL											$1,799		
SUBTOTAL						$6,000				$9,590	$15,590		
OVERHEAD, BOND	16.0%					$960				$1,534	$2,494		
PROFIT	10.0%					$600				$959	$1,559		
COST SUB-TOTAL						$7,560				$12,083	$19,643		
CONTINGENCY	20.0%					$1,512				$2,417	$3,929		
SUBTOTAL						$9,072				$14,500	$23,572		
S&A	5.5%					$499				$798	$1,296		
TOTAL THIS SHEET						$9,571				$15,298	$24,869		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5678EC10
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER O2 TRIM CONTROL
ANALYSIS DATE: 04-10-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	23572.
B. SIOH	$	1297.
C. DESIGN COST	$	1415.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	23656.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	23656.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	1537.	$ 4488.	12.48	56011.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		1537.	$ 4488.		$ 56011.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1799.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -16389.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -16389.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 18484.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 2689.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 39622.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.67
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 8.80

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5678
ENERGY CONSERVATION OPPORTUNITY: ECO-12
SYSTEM MODIFICATION: STACK ECONOMIZERS
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-12, install stack economizer for boilers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	16,330	16,330
ECO	--	--	16,134	16,134
Savings (Baseline-ECO)	0	0	196	196

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 0 MMBtu/Yr X $4.0141 /MMBtu = $0 per year

Nat. Gas: 196 MMBtu/Yr X $2.92 /MMBtu = $572 per year

Total Energy Cost Savings: $0 + $572 = $572 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $0 per year

Total: $0 - $0 = $0 per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	16330.
PEAK DAY GAS CONSUMP., 1000 CU FT	136.
ELECTRICAL CONSUMPTION, KWH	233241.
PEAK KW DEMAND (15 MIN BASIS)	106.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	233241.
ON-PEAK KW DEMAND (15 MIN BASIS)	106.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2808
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5678 BOILER ECO-6

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	16134.
PEAK DAY GAS CONSUMP., 1000 CU FT	136.
ELECTRICAL CONSUMPTION, KWH	233241.
PEAK KW DEMAND (15 MIN BASIS)	106.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	233241.
ON-PEAK KW DEMAND (15 MIN BASIS)	106.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2796
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.	DACA 59-90-C-0087
EFFECTIVE PRICING DATE	APR. 91
DATE PREPARED	11-Apr-91
PROJECT	ENERGY SURVEY OF ARMY BOILER AND CHILLER
LOCATION	FT. SILL, OKLAHOMA
CODE A [X] CODE B [ ] CODE C [ ] OTHER ____	
DRAWING NO.	
SHT	OF
ESTIMATOR	KC
CHECKED BY	CEL

STACK ECONOMIZER ECO-11	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
BLDG. 5678 / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
STACK ECONOMIZER & ACC.	2	EA	247.9	495.8	24	11900			3966.00	7932.00	$19,832	742	1484
SUBTOTAL						$11,900				$7,932	$19,832		
OVERHEAD, BOND	16%					$1,904				$1,269	$3,173		
PROFIT	10%					$1,190				$793	$1,983		
COST SUB-TOTAL						$14,994				$9,994	$24,988		
CONTINGENCY	20%					$2,999				$1,999	$4,998		
SUBTOTAL						$17,993				$11,993	$29,986		
S&A	5.5%					$990				$660	$1,649		
TOTAL THIS SHEET						$18,982				$12,653	$31,635		

DA FOR[illegible]R, APR 85

Kentube
FABRICATED PRODUCTS

QUOTATION

TO	KMC Engineers	/318-10350-0-0

ITEM	QUANTITY	DESCRIPTION	UNIT AMOUNT	AMOUNT
		SUGGESTED ACCESSORIES (Quantities below are for each unit)		
	1	Bolted access manway in casing, approximately 16" Square, carbon steel construction.	$ 300.	$ 300.
	1	1/2" Threaded connection for safety relief valve on header.	$ 100.	$ 100.
	1	1/2" Threaded safety relief valve, Kunkle series 927.	$ 555.	$ 555.
		** All prepaid and bill shipments will be at the billable freight amount plus a service charge of 10%. A service charge is not required for collect shipments or third party billing.		
		KENTUBE is a member of the AMERICAN BOILER MANUFACTURERS ASSOCIATION		

Kentube FABRICATED PRODUCTS

4150 S. Elwood
Tulsa, Oklahoma 74107
Phone: (918) 446-4561
FAX: (918) 446-4340

QUOTATION

TO	QUOTATION DATE	YOUR REFERENCE	OUR REFERENCE
EMC Engineers 2750 South Wadsworth Blvd. Denver, CO 80227 Attention: Mr. Dennis Jones	04/10/91		318-10350-0-0
	SHIPPING ESTIMATE: 8 Weeks*	TERMS: Net 30 Days	PAGE 1 OF 2
	SHIPPING DESTINATION:	F.O.B.: Kentube Shop**	

THANK YOU FOR YOUR INQUIRY. WE APPRECIATE THE OPPORTUNITY TO PROPOSE THE FOLLOWING:

ITEM	QUANTITY	DESCRIPTION	UNIT AMOUNT	AMOUNT
	8	Kentube RETROMISER Fuel Economizer Cylindrical Model 201140, in accordance with the attached performance specifications. DESIGN FEATURES Finned tube unit; 4 Fins per inch; Vertical gas flow; Counter-current flow Fuel type: NATURAL GAS. Estimated Shipping Weight - 1768. LBS. Pressure parts to Section I of the ASME Boiler & Pressure Vessel Code. External 2" insulation with weatherproof, corrugated casing is included. Threaded drain and vent connections included. Kentube manually operated sootblower, integral with unit, included. Requires 85 psig to 250 psig supply pressure.	$ 4914.	$ 39312.

ENCLOSURES

cc: Ted D. Miller Associates

NOTE: All shipping estimates are based on "after receipt of order" and "after final print approvals" as required. Shipments can often be improved upon request. Please contact Kentube.
Prices firm for 30 days and subject to change thereafter. No provision is made for Federal, State or Municipal taxes. All orders are subject to acceptance or rejection by the Credit Department of Kentube and to the Terms of Sale attached.

YOUR REPRESENTATIVE IS:	YOUR ORDER WILL RECEIVE OUR PROMPT ATTENTION
Ted D. Miller Associates 2140 South Ivanhoe Denver, CO 80222	KENTUBE FABRICATED PRODUCTS Larry Wolfenbarger Product Sales Engineer

OFT
CUSTOMER
EMC Engineers
PROPOSAL 318-10350-0-0
RUN 00

KENTUBE
4150 S. ELWOOD
TULSA, OKLAHOMA

PRINTED 04/10/91
TIME 09 HRS 06 MINS
CUST. REFERENCE

CYLINDRICAL FUEL ECONOMIZER MODEL 201140

OVERALL PERFORMANCE

COUNTER CURRENT FLOW
FLUID CIRCULATED IN TUBES IS WATER
HEAT EXCHANGED 552023. BTU/HR
U EXTERNAL 6.938 BTU/HR-SQFT-F
LMTD 160.3 DEG F

OVERALL CONSTRUCTION

VERTICAL GAS FLOW
DIMENSIONS
DIM A (HEIGHT) 7'-3/4"
DIM B (NOZ C-C) 0'-5 1/2"
DIM C (DIAMETER) 2'-9 3/4"
DRAWING NO V- 4
SOOT BLOWERS ARE BUILT IN
NOZZLE SIZE 2.0 IN
SURFACE AREA 496. SQFT
LIQUID WEIGHT 175. LB
UNIT WEIGHT(DRY) 1768. LB

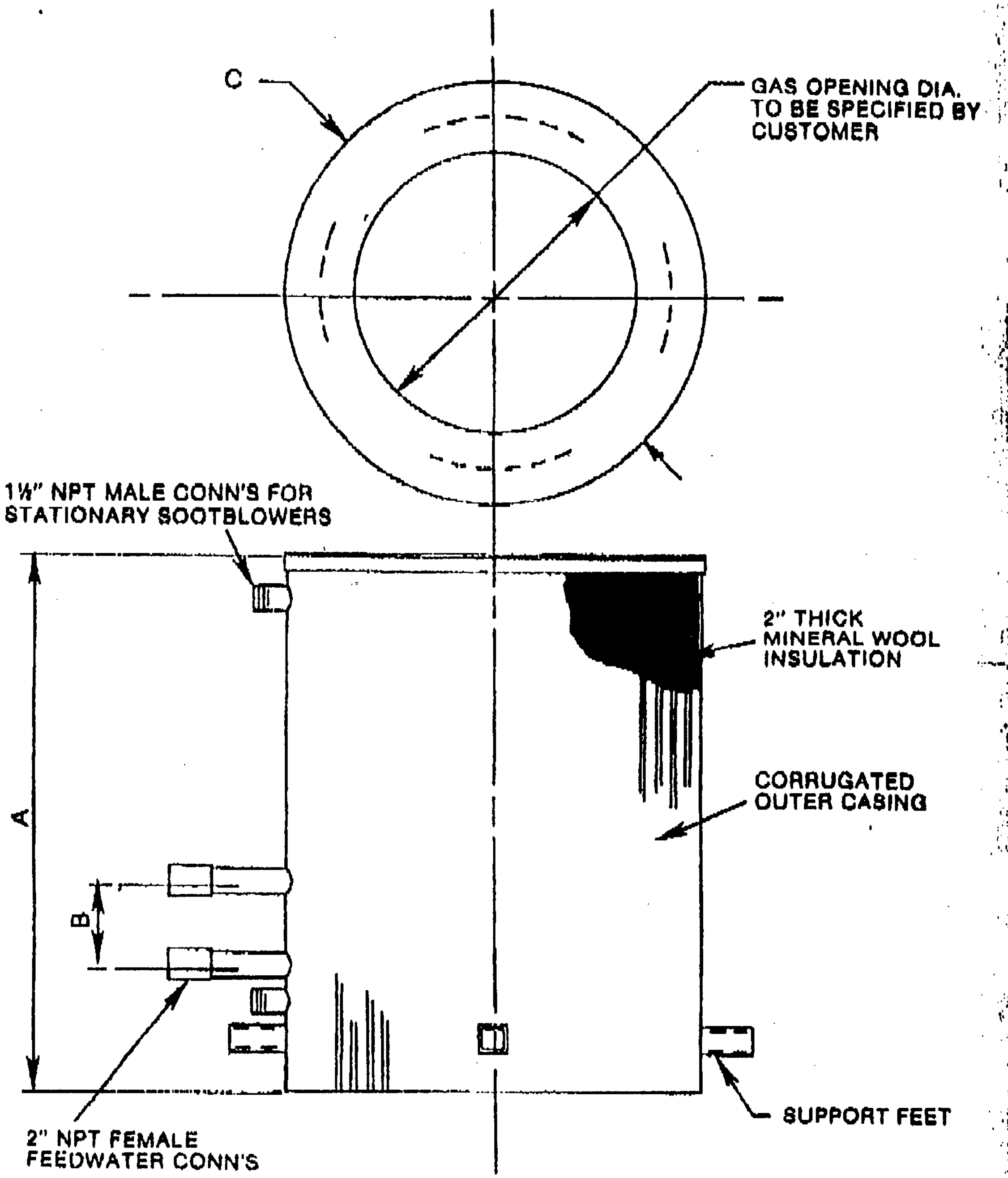
PERFORMANCE SPECIFICATIONS

	TUBE SIDE ↓	GAS SIDE ↑	
FLOW RATE	8620.	10307.	LB/HR
TEMP IN	180.0	500.0	DEG F
TEMP OUT	243.9	299.1	DEG F
PRES IN	150.0 PSIG	14.7	PSIA
PRES DROP	1.1 PSI	.77	IN WATER

CONSTRUCTION SPECIFICATIONS
TUBE SIDE

DESIGN PRESSURE		490.	PSI
TEST PRESSURE		735.	PSI
DESIGN TEMPERATURE		700.	DEG
TUBE	OUTSIDE DIA	2.000	IN
	MATERIAL	C/STL	
FIN	THICKNESS	.060	IN
	PITCH	4.00	FINS.
	MATERIAL	C/STL	
INSULATION			
	MATERIAL	MINERAL WOO[L]	
	THICKNESS	2.0	IN

Kentube cylindrical
[illegible]® fuel economizer



SEE PERFORMANCE DATA SHEET FOR DIMENSIONS

Kentube
4150 South Elwood • Tulsa, Oklahoma 47107
918/446-4551 • Telex: 49-2353

CRFE-V4

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5678EC11
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ECONOMIZER AIR PREHEAT
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	29986.
B. SIOH	$	1650.
C. DESIGN COST	$	1800.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	30092.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	30092.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	196.	$ 572.	17.52	10027.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		196.	$ 572.		$ 10027.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3309.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 572.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 10027.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .33
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 52.58

CENTRAL PLANT 5900

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO-1
SYSTEM MODIFICATION: ADD INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY: CHILLER 1, 2, 3, 4, AND 5

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-1, install instrumentation to facilitate efficient operation of chiller plant.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	1,886	2,743,132	--	9,362
ECO	1,886	2,224,028	--	7,591
Savings (Baseline-ECO)	0	519,104	0	1,772

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	1772 MMBtu/Yr	X	$4.0141 /MMBtu	=	$7,112 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$7,112**	**+**	**$0**	**=**	**$7,112 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $319 per year

Total: $0 - $319 = ($319)per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	172256.
PEAK DAY GAS CONSUMP., 1000 CU FT	1663.
ELECTRICAL CONSUMPTION, KWH	2224028.
PEAK KW DEMAND (15 MIN BASIS)	1886.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2224028.
ON-PEAK KW DEMAND (15 MIN BASIS)	1886.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	84
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3443
BOILER 4	2445
BOILER 5	1720
BOILER 6	910
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Total additional annual energy use due to operating chillers 3, 4, and 5 more than necessary: 519,104 kWh/yr
Total electrical consumption: 2,743,132 kWh/yr

PC-CUBE VERSION 2.0.3

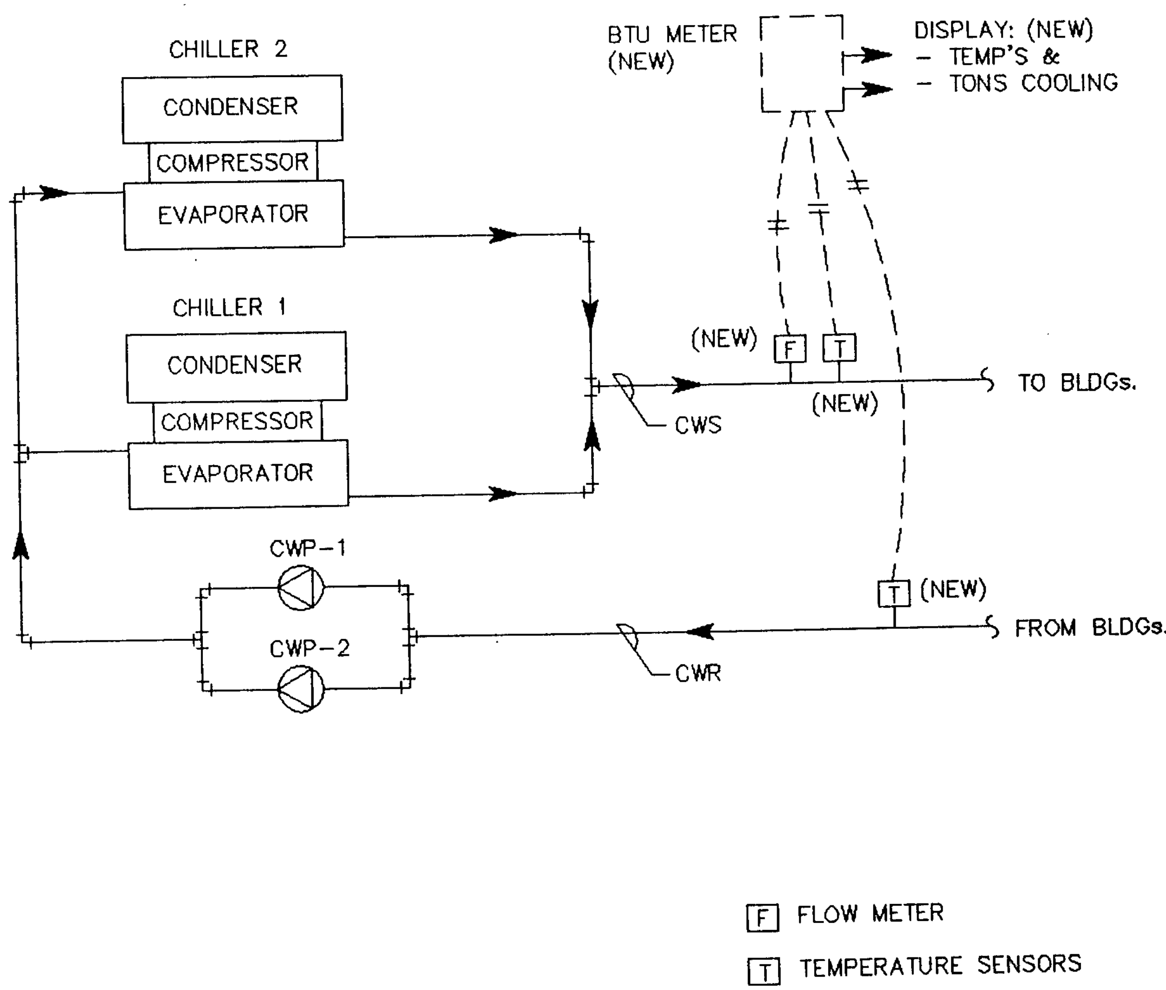
CENTRAL PLANT 5900

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	172256.
PEAK DAY GAS CONSUMP., 1000 CU FT	1663.
ELECTRICAL CONSUMPTION, KWH	2224028.
PEAK KW DEMAND (15 MIN BASIS)	1886.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2224028.
ON-PEAK KW DEMAND (15 MIN BASIS)	1886.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	84
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3443
BOILER 4	2445
BOILER 5	1720
BOILER 6	910
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

ECO-1, INSTRUMENTATION FOR CHILLER PLANT (TYPICAL)



[C-ECO-1.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

☐ CODE A ☒ CODE B ☐ CODE C
☐ OTHER ________

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO-1 BLDG. 5900 INSTRUMENTATION	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 5 CHILLERS													
CHWS TEMPERATURE SENSOR	1	EA			$176	$176			$328	$328	$504		
CHWR TEMPERATURE SENSOR	1	EA			$176	$176			$328	$328	$504		
INSERT. FLOW METER	1	EA			$197	$197			$764	$764	$961		
BTU METER	1	EA	6.0	6.0	$20	$118			$820	$820	$938		
LED DISPLAY	2	EA							$60	$120	$120		
LED INSTALLATION	2	EA	4.6	9.2	$20	$180			$158	$316	$496		
SUBTOTAL						$847				$2,676	$3,523		
OVERHEAD, BOND	16%					$136				$428	$564		
PROFIT	10%					$85				$268	$352		
COST SUB-TOTAL						$1,067				$3,372	$4,439		
CONTINGENCY	20%					$213				$674	$888		
SUBTOTAL						$1,281				$4,046	$5,327		
S&A	5.5%					$70				$223	$293		
TOTAL THIS SHEET						$1,351				$4,269	$5,620		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C5900ECO
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER INSTRUMENTATION
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	5327.
B. SIOH	$	293.
C. DESIGN COST	$	320.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	5346.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	5346.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	1772.	$ 7113.	8.78	62450.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	0.	$ 0.	12.48	0.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		1772.	$ 7113.		$ 62450.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -319.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -2906.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -2906.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 20609.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 6794.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 59544.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 11.14
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 .79

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO-2
SYSTEM MODIFICATION: CHILLER OPTIMIZATION, ADD INSTRUMENTATION
SYSTEMS TO MODIFY: CHILLER 1, 2, 3, 4, AND 5

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-2, install instrumentation connected to EMCS for chiller optimization.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	1,886	2,743,132	--	9,362
ECO	1,877	2,203,702	--	7,521
Savings (Baseline-ECO)	9	539,430	0	1,841

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	1841 MMBtu/Yr	X	$4.0141 /MMBtu	=	$7,390 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$7,390**	+	**$0**	=	**$7,390 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 9 kW/month X $1.787 /kW X 12 months/year

= (+) $193 per year

Maintenance: = (-) $1,188 per year

Total: $193 - $1,188 = ($995)per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	172256.
PEAK DAY GAS CONSUMP., 1000 CU FT	1663.
ELECTRICAL CONSUMPTION, KWH	2224028.
PEAK KW DEMAND (15 MIN BASIS)	1886.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2224028.
ON-PEAK KW DEMAND (15 MIN BASIS)	1886.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	84
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3443
BOILER 4	2445
BOILER 5	1720
BOILER 6	910
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Total additional annual energy use due to operating chillers 3, 4, and 5 more than necessary: 519,104 kWh/yr
Total electrical consumption: 2,743,132 kWh/yr

PC-CUBE VERSION 2.0.3

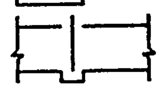
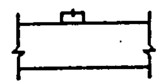
CENTRAL PLANT 5900 CHILLER ECO-2

** TOTAL **

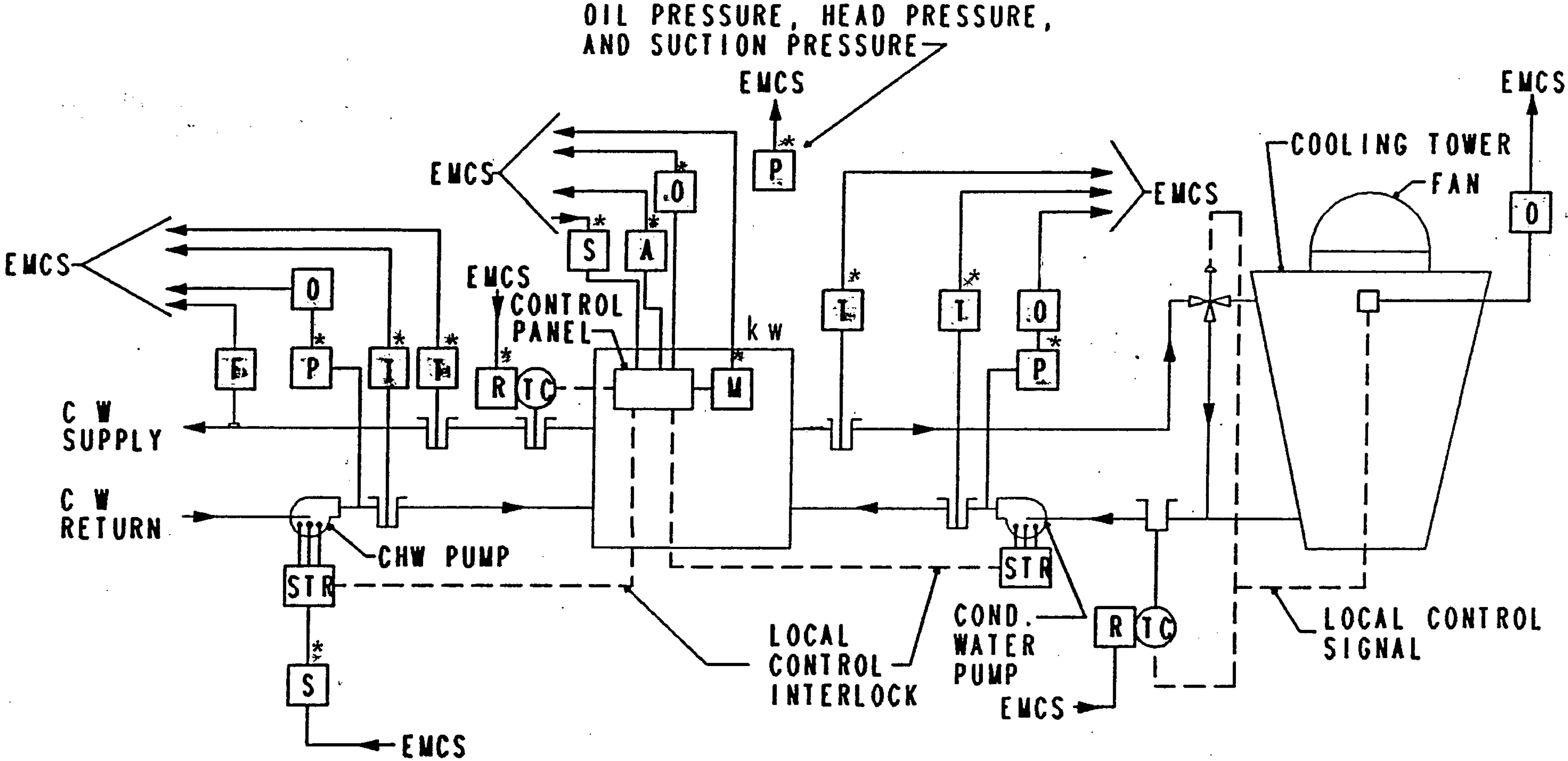
SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	172256.
PEAK DAY GAS CONSUMP., 1000 CU FT	1663.
ELECTRICAL CONSUMPTION, KWH	2203702.
PEAK KW DEMAND (15 MIN BASIS)	1877.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2203702.
ON-PEAK KW DEMAND (15 MIN BASIS)	1877.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2782
CHILLER 3	973
CHILLER 4	482
CHILLER 5	101
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3443
BOILER 4	2445
BOILER 5	1720
BOILER 6	910
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

→	EMCS	SIGNAL TRANSMITTED TO EMCS
←	EMCS	SIGNAL TRANSMITTED FROM EMCS
	A	ALARM CONTACT SIGNAL
	E	ECONOMIZER CONTROL INTERFACE
	F	FLOW INDICATION
	FL	FLAME INDICATION
	H	HUMIDITY INDICATION
	P	PRESSURE INDICATION
	LV	LEVEL INDICATION
	M	METER
	O	ON-OFF STATUS SIGNAL
	DP	DIFFERENTIAL PRESSURE SWITCH
	R	CONTROLLER RESET INTERFACE
	S	START-STOP INTERFACE
	T	TEMPERATURE INDICATION
	V	VENTILATION/RECIRCULATION CONTROL
	PS	POSITION
	O_2	FLUE GAS ANALYSIS, OXYGEN
	Co	FLUE GAS ANALYSIS, CARBON MONOXIDE

FD	FURNACE DRAFT DIFFERENTIAL PRESSURE
DS	HIGH-LOW DEMAND SIGNAL SELECTOR
TC	TEMPERATURE CONTROLLER
PC	PRESSURE CONTROLLER
STR	MOTOR STARTER
	SENSOR INSTALLED IN THERMOMETER WELL
	SENSOR INSTALLED IN DUCT OR PLENUM
CHW	CHILLED WATER
EA	EXHAUST AIR
SA	SUPPLY AIR
RA	RETURN AIR
OA	OUTSIDE AIR
MA	MIXED AIR
WB	WET BULB
DB	DRY BULB
OAD	OUTSIDE AIR DAMPER
RAD	RETURN AIR DAMPER
EAD	EXHAUST AIR DAMPER
MZD	MULTIZONE DAMPER
RH	RELATIVE HUMIDITY

Symbols and Abbreviations



Waler cooled chiller

* - Points included on proposed EMCS design, existing.
All other points are new.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

[ ] CODE A [X] CODE B [ ] CODE C

[ ] OTHER ____________

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO-2 BLDG. 5900		Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
OPTIMIZE CHILLER SEQUENCE / TASK DESCRIPTION		No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 5 CHILLERS														
CHWS/R TEMPERATURE SENSOR	*	10	LS			176	1760			328.00	3280.00	$8,320		
CHWS/R TEMPERATURE SENSOR		2	LS			176	352			328.00	656.00	$1,008		
CNWS/R TEMPERATURE SENSOR	*	10	LS			176	1760			328.00	3280.00	$8,320		
INSERT. FLOW METER		6	LS			197	1182			764.00	4584.00	$5,766		
CHWP ST/SP	*	5	LS			39	196			226.00	1130.00	$2,456		
CNWP ST/SP	*	5	LS			39	196			226.00	1130.00	$2,456		
DP (LIQUID) PUMP STATUS	*	10	LS			155	1550			205	2050	5650		
COOLING TOWER ST/SP		9	LS			39.2	352.8			226	2034	2386.8		
COOLING TOWER ST/SP STATUS		9	LS			104	936			53.00	477.00	$1,413		
CHW TEMP CONTROL	*	1	EA	5.5	5.5	20	108			558.00	558.00	$1,224		
CHILLER ST/SP	*	1	EA	2.0	2.0	20	39			226.00	226.00	$491		
CHW TEMP CONTROL	*	5	EA	5.5	27.5	20	539			558.00	2790.00	$6,119		
CHILLER ST/SP	*	5	EA	2.0	10.0	20	196			226.00	1130.00	$2,456		
kW TRANSDUCER	*	5	LS			226	1130			374.00	1870.00	$4,870		
CURRENT TRANSDUCER		5	LS			126	630			270.00	1350.00	$1,980		
FID PANEL & ACCESSORIES	*	1	LS			208	208			3681.00	3681.00	$7,570		
FID SOFTWARE COMMISSIONING		1	EA	6.0	6.0	45	270					$270		
FID TESTING		1	EA	6	6.0	45	270					$270		
CREDIT FROM EMCS PROJECT	*						-7682				-21125.00	($28,807)		
SUBTOTAL							$3,993				$9,101	$13,094		
OVERHEAD, BOND		16%					$639				$1,456	$2,095		
PROFIT		10%					$399				$910	$1,309		
COST SUB-TOTAL							$5,031				$11,467	$16,498		
CONTINGENCY		20%					$1,006				$2,293	$3,300		
SUBTOTAL							$6,037				$13,761	$19,798		
S&A		5.5%					$332				$757	$1,089		
TOTAL THIS SHEET							$6,369				$14,518	$20,887		

DA FORM [illegible], APR 85

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: C5900ECO
LCCID 1.035

INSTALLATION & LOCATION: FT. SILL, OKLAHOMA   REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000   ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991   DISCRETE PORTION NAME: CHILLER OPTIMIZATION
ANALYSIS DATE: 04-12-91   ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	19798.
B. SIOH	$	1089.
C. DESIGN COST	$	1188.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	19868.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	19868.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	1857.	$ 7454.	8.78	65446.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	0.	$ 0.	12.48	0.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		1857.	$ 7454.		$ 65446.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -995.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -9064.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -9064.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 21597.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 6459.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 56382.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 2.84
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 3.08

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO-3
SYSTEM MODIFICATION: MINOR RENOVATION & ANNUAL MAINTENANCE
SYSTEMS TO MODIFY: CHILLER 1, 2, 3, 4, AND 5

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-3, renovate or replace existing chillers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	1,886	2,743,000	--	9,362
ECO	1,732	2,025,000	--	6,911
Savings (Baseline-ECO)	154	718,000	0	2,451

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	2451 MMBtu/Yr	X	$4.0141 /MMBtu	=	$9,837 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$9,837**	+	**$0**	=	**$9,837 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 154 kW/month X $1.787 /kW X 12 months/year

= (+) $3,302 per year

Maintenance: = (-) $3,000 per year

Total: $3,302 - $3,000 = $302 per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	172256.
PEAK DAY GAS CONSUMP., 1000 CU FT	1663.
ELECTRICAL CONSUMPTION, KWH	2224028.
PEAK KW DEMAND (15 MIN BASIS)	1886.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2224028.
ON-PEAK KW DEMAND (15 MIN BASIS)	1886.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	84
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3443
BOILER 4	2445
BOILER 5	1720
BOILER 6	910
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Total additional annual energy use due to operating chillers 3, 4, and 5 more than necessary: 519,104 kWh/yr

Total electrical consumption: 2,743,132 kWh/yr

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 CHILLER ECO-3

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	172256.
PEAK DAY GAS CONSUMP., 1000 CU FT	1663.
ELECTRICAL CONSUMPTION, KWH	2025466.
PEAK KW DEMAND (15 MIN BASIS)	1732.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2025466.
ON-PEAK KW DEMAND (15 MIN BASIS)	1732.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	1975
CHILLER 3	765
CHILLER 4	143
CHILLER 5	63
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3443
BOILER 4	2445
BOILER 5	1720
BOILER 6	910
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C
[ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 12-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO-3 BLDG. 5900 / HIGH EFFICIENCY CHILLERS / TASK DESCRIPTION	Quantity No. Of Units	Quantity Unit Meas	LABOR MH/ Unit	LABOR Total Hrs	LABOR Unit Price	LABOR Cost	EQUIPMENT Unit Price	EQUIPMENT Cost	MATERIAL Unit Price	MATERIAL Cost	TOTAL	SHIPPING Unit Wt	SHIPPING Total Wt
CHILLER MAINTENANCE													
400 TON CHILLER MINOR MAINTENANCE	4	LS			1984	7937					$7,937		
450 TON CHILLER MINOR MAINTENANCE	1	LS			1984	1984					$1,984		
NEW COOLING TOWER	1	LS							19675	19675	$19,675		
REMOVE EXISTING COOLING TOWER	1	LS	36.0	36.0	24	864	550	550			$1,414		
SUBTOTAL						$10,785		$550		$19,675	$31,010		
OVERHEAD, BOND	16%					$1,726		$88		$3,148	$4,962		
PROFIT	10%					$1,078		$55		$1,968	$3,101		
COST SUB-TOTAL						$13,589		$693		$24,791	$39,072		
CONTINGENCY	20%					$2,718		$139		$4,958	$7,814		
SUBTOTAL						$16,306		$832		$29,749	$46,887		
S&A	5.5%					$897		$46		$1,636	$2,579		
TOTAL THIS SHEET						$17,203		$877		$31,385	$49,465		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C5900EC3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER MAINTENANCE
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	44749.
B. SIOH	$	2462.
C. DESIGN COST	$	2685.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	44906.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	44906.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	679.	$ 2726.	8.78	23937.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	0.	$ 0.	12.48	0.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		679.	$ 2726.		$ 23937.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 302.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 2751.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 2751.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 7899.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 3028.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 26688.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .59
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 14.83

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO- 4
SYSTEM MODIFICATION: INSTALL ICE STORAGE COOLING SYSTEM
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Hand calculation sheet was prepared to determine the energy savings for ECO-4, install ice storage system for HVAC cooling.
It was estimated that the peak electrical demand can be saved by installing ice storage cooling system.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	1,890	0	0	0

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 0 MMBtu/Yr X $4.0141 /MMBtu = $0 per year

Nat. Gas: 0 MMBtu/Yr X $2.92 /MMBtu = $0 per year

Total Energy Cost Savings: $0 + $0 = $0 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 1890 kW/month X $1.787 /kW X 12 months/year

= (+) $40,529 per year

Maintenance: = (-) $0 per year

Total: $40,529 - $0 = $40,529 per year

[ECO-SHT.WK3]

A new application of an old idea that can cut air conditioning energy costs in half.

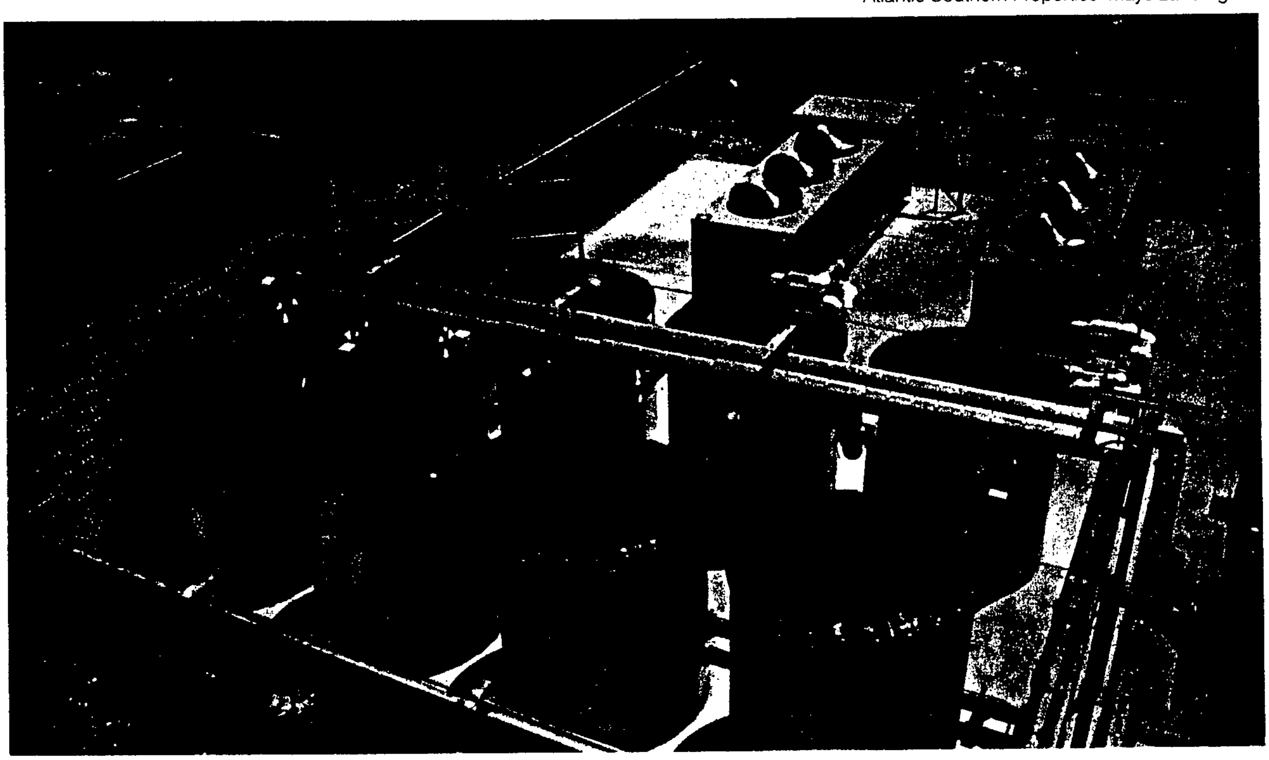
Air conditioning during summer daytime hours is the largest single contributor to utility "peak demand" charges. After noon, as more air conditioners are needed to maintain comfortable temperatures, the increased demand for electricity adds to that already created by lighting, operating equipment, computers and thousands of other uses. This requires the utility to bring additional, more costly generating sources on line to handle its increased demand. Commercial users whose large air conditioning loads contribute to these added generating requirements are assessed an additional charge based on their highest on-peak demand for electricity.

An Ice Bank Stored Cooling System is either a load-shifting or load-leveling method which will significantly lower demand charges during the air conditioning season and, consequently, energy costs. It uses a standard packaged chiller to produce solid ice at night during off-peak periods when the building's electrical needs are at a minimum. The ice is built and stored in modular ice tanks to provide cooling to help meet the building's air conditioning load requirement the following day.

Making ice at night and using its stored energy during the day is not a new or experimental idea. This concept had been employed for years in cooling short-peak applications such as churches and theatres. However, longer peak uses were served by air-source rooftop and chiller-type air conditioners which were less costly to install. Now there is renewed interest in a broad use of ice-making systems by both users and utilities as the best way to offset rising operating costs. In fact, Stored Cooling Systems are what summer-peaking utilities *must have* to avoid the unbearable costs of new generating plants.

Ice Banks not only can cut operating costs in half but they can also substantially reduce capital outlays when systems are suitably designed for new commercial and industrial buildings. Engineers can specify half-size chillers operating 24 hours a day rather than full-size chillers operating only 10 or 12 hours per day. In retrofit applications, an Ice Bank Stored Cooling System can often provide cooling for an addition to a building without adding chiller capacity.

Atlantic Southern Properties Mays Landing NJ



How the LEVLOAD System Works

The LEVLOAD Ice Bank is a modular, insulated polyethylene tank containing a spiral-wound plastic tube heat exchanger surrounded with water. They are available in four sizes – 90, 100, 190 and 570 ton-hours. At night, a 75 percent water - 25 percent glycol solution from a standard packaged air conditioning chiller circulates through the heat exchanger and extracts heat until eventually all the water in the tank is frozen solid. The ice is built uniformly throughout the tank by the patented temperature-averaging effect of closely spaced counterflow heat exchanger tubes, Figure 5. Water does not become surrounded by ice during the freezing process and can move freely as ice forms, preventing stress or damage to the tank.

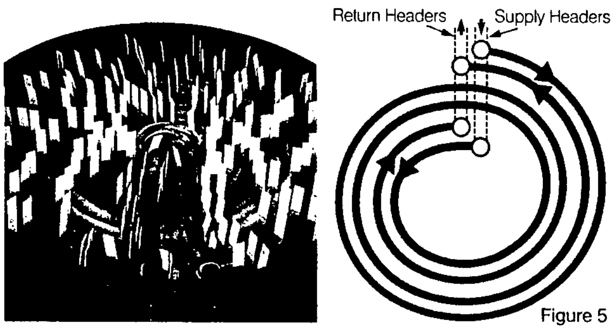


Figure 5

Typical flow diagrams for a Partial Storage System are shown in Figures 6 and 7.

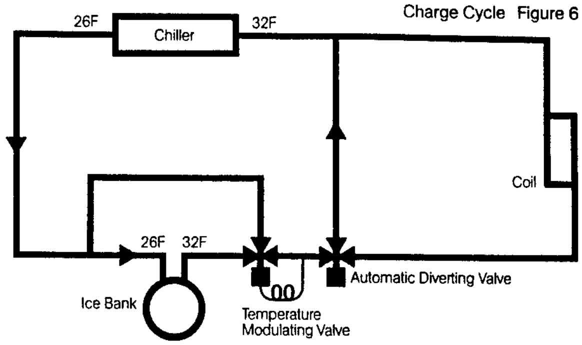
At night, the water-glycol solution circulates through the chiller and the Ice Bank heat exchanger, bypassing the air handler coil. The fluid is at 26F and freezes the water surrounding the heat exchanger.

During the day, the solution is cooled by the Ice Bank from 52F to 34F. A temperature modulating valve set at 44F in a bypass loop around the Ice Bank permits a sufficient quantity of 52F fluid to bypass the Ice Bank, mix with the 34F fluid, and achieve the desired 44F temperature. The 44F fluid enters the coil, where it cools air from 75F to 55F. The fluid leaves the coil at 60F, enters the chiller and is cooled to 52F.

It should be noted that, while making ice at night, the chiller must cool the water-glycol solution to 26F, rather than produce 44 or 45F water temperatures required for conventional air conditioning systems. This has the effect of "derating" the nominal chiller capacity by approximately 30 percent. Compressor efficiency, however, is only slightly reduced because lower nighttime temperatures result in cooler condenser water from the cooling tower and help keep the unit operating efficiently. Similarly, air cooled chillers benefit from cooler condenser entering air temperatures at night.

The temperature modulating valve in the bypass loop has the added advantage of providing unlimited capacity control. During many mild temperature days in the spring and fall, the chiller will be capable of providing all the necessary cooling for the building without assistance from stored cooling. When the building's actual cooling load is equal to or lower than the chiller capacity, all of the system coolant flows through the bypass loop, as in Figure 8.

Charge Cycle Figure 6



Discharge Cycle Figure 7

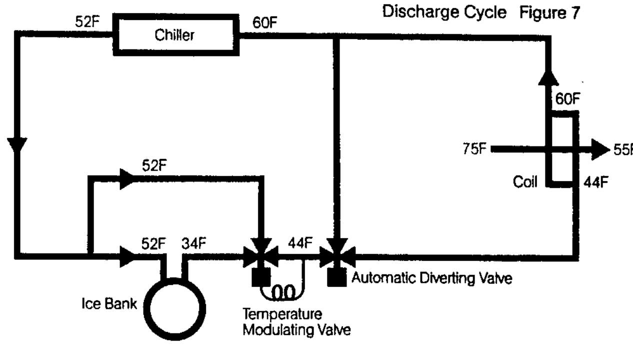
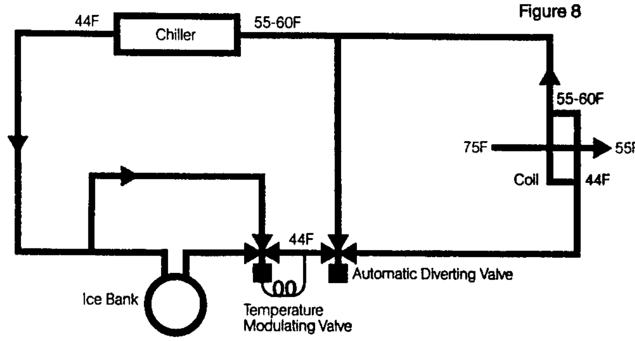


Figure 8



The glycol recommended for the solution is an ethylene glycol-based industrial coolant, such as Dow Chemical Company's Dowtherm® SR-1 or Union Carbide Corporation's UCARTHERM,® which are specially formulated for low viscosity and superior heat transfer properties. These contain a multi-component corrosion inhibitor system which is effective with most materials of construction, including aluminum, copper, solder and plastics. Unlike automotive-type anti-freeze, they produce no films and contain no anti-leak agents to interfere with heat transfer efficiency and permit use of standard system pumps, seals and air handler coils. However, because of the slight difference in heat transfer coefficient between water-glycol and plain water, coil capacity should be increased by approximately 5 percent. It is also important that the water and glycol be thoroughly mixed before the solution enters the system.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5900EC4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ICE STORAGE COOLING SYSTEM
ANALYSIS DATE: 04-18-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	504000.
B. SIOH	$	27720.
C. DESIGN COST	$	30240.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	505764.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	505764.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 40529.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 472163.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 472163.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 0.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 40529.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 472163.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .93
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 12.48

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO– 5(A)
SYSTEM MODIFICATION: TWO SPEED FANS FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER #1

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO–5, install two–speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	––	42,802	––	146
ECO	––	26,887	––	92
Savings (Baseline–ECO)	0	15,915	0	54

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 54 MMBtu/Yr X $4.0141 /MMBtu = $218 per year

Nat. Gas: 0 MMBtu/Yr X $2.92 /MMBtu = $0 per year

Total Energy Cost Savings: $218 + $0 = $218 per year

NON–ENERGY SAVINGS (+), COST (–):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (–) $0 per year

Total: $0 – $0 = $0 per year

[ECO–SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input (part 7). The control sequence is:

- 0-50% load, fan 1, half speed cycling.
- 50-100% load, fan 1 full speed cycling.

kWh per bin, for % design loads less than 50% load = (fan 1 power kW) * 14% * (%design load / 50) * 4 hours per bin * days per month.

kWh per bin, for % design loads 50% to 100% load = (fan 1 power kW * ((% design load)/ 100) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 5900 (COOLING TOWER 1 ONLY)	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	78
– WATER FLOW (gpm)	1200
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	4980
HEAT REJECTION CAPACITY (Btu/min)	99600
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	41.58
TOTAL ENTHALPY	61.58
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	75198
MOTOR DATA	
– FAN 1 POWER (kW)	19.2
– FAN 2 POWER (kW)	0
– FAN 3 POWER (kW)	0
– FAN 4 POWER (kW)	0

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET–BULB AVERAGES (4 hour bins)						DESIGN
	1–4	5–8	9–12	13–16	17–20	21–24	WB
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	78
MAY	57.1	56.6	61.2	63.9	63	59.4	78
JUNE	66.8	66.6	69.9	71	70.5	68.2	78
JULY	70.8	70.9	74.5	76	74.9	72.6	78
AUGUST	66.9	67	71	72	71	68.5	78
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	78
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	78

ENTHALPY FOR AVERAGE WET-BULBS							DESIGN ENTHALPY
	1-4	5-8	9-12	13-16	17-20	21-24	
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	41.58
MAY	24.53	24.21	27.28	29.23	28.57	26.06	41.58
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	41.58
JULY	34.77	34.86	38.14	39.57	38.52	36.37	41.58
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	41.58
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	41.58
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	41.58

COOLING PROFILE OF CENTRAL PLANTS							PEAK LOAD (Btuh)
	1-4	5-8	9-12	13-16	17-20	21-24	
APRIL	0	0	0	0	0	0	0
MAY	0.9	0.9	0.9	0.9	0.9	0.9	15953000
JUNE	0.9	0.9	0.9	0.9	0.9	0.9	19533000
JULY	0.9	0.9	0.9	0.9	0.9	0.9	19533000
AUGUST	0.9	0.9	0.9	0.9	0.9	0.9	19533000
SEPTEMBER	0.9	0.9	0.9	0.9	0.9	0.9	19533000
OCTOBER	0	0	0	0	0	0	0

RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY							DAYS PER MONTH OPER.
	1-4	5-8	9-12	13-16	17-20	21-24	
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	1.9	1.9	1.7	1.6	1.7	1.8	31
JUNE	1.5	1.5	1.4	1.3	1.4	1.4	30
JULY	1.3	1.3	1.2	1.1	1.2	1.3	31
AUGUST	1.5	1.5	1.3	1.3	1.3	1.4	31
SEPTEMBER	1.6	1.6	1.5	1.4	1.5	1.6	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	% DESIGN LOAD						DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	39.7	39.3	42.9	45.4	44.5	41.4	31
JUNE	59.8	59.5	65.3	67.6	66.5	62.1	30
JULY	67.1	67.4	76.8	81.8	78.1	71.4	31
AUGUST	59.9	60.1	67.6	69.9	67.6	62.6	31
SEPTEMBER	57.2	57.0	61.4	63.2	60.7	58.0	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	SINGLE SPEED CONTROL (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	945	937	1020	1082	1060	985	
JUNE	1377	1370	1504	1557	1532	1431	
JULY	1598	1604	1828	1947	1858	1700	
AUGUST	1427	1430	1609	1664	1609	1491	
SEPTEMBER	1319	1312	1414	1456	1399	1335	
OCTOBER	0	0	0	0	0	0	
TOTAL	6666	6653	7376	7706	7459	6942	42802

	TWO SPEED CONTROL (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	265	262	286	303	297	276	
JUNE	773	759	1027	1133	1083	880	
JULY	1149	1160	1609	1847	1669	1352	
AUGUST	806	813	1171	1281	1171	935	
SEPTEMBER	656	643	847	930	816	689	
OCTOBER	0	0	0	0	0	0	
TOTAL	3649	3638	4939	5494	5036	4132	26887

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CODE A [X] CODE B [ ] CODE C

OTHER ________

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO BLDG. 5900	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
2-SPEED COOLING TOWER TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
25 HP 2-SPD MOTOR	1	EA	3.2	3.2	20	62			2730.00	2730.00	$2,792		
2-SPD MOTOR STARTER	1	EA	4.2	4.2	20	82			859.00	859.00	$941		
MOTOR FEEDER	1	LS	4.1	4.1	20	80			20.00	20.00	$100		
REMOVE OLD MOTOR	1	EA	3.3	3.3	20	65					$65		
REMOVE OLD STR	1	EA	4.2	4.2	20	82					$82		
PNEUMATIC THERMOSTAT	2	EA	1	2	19.6	39.2			34.12	68.24	107.44		
FIX COOLING TOWER # 2													
2-SPD MOTOR STARTER	1	EA	4.2	4.2	20	82			859.00	859.00	$941		
REMOVE OLD STR	1	EA	4.2	4.2	19.6	82.32					82.32		
SUBTOTAL						$575				$4,536	$5,112		
OVERHEAD, BOND	16%					$92				$726	$818		
PROFIT	10%					$58				$454	$511		
COST SUB-TOTAL						$725				$5,716	$6,440		
CONTINGENCY	20%					$145				$1,143	$1,288		
SUBTOTAL						$870				$6,859	$7,729		
S&A	5.5%					$48				$377	$425		
TOTAL THIS SHEET						$918				$7,236	$8,154		

DA FORM [illegible], APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5900EC5A
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	7729.
B. SIOH	$	425.
C. DESIGN COST	$	464.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	7756.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	7756.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	54.	$ 218.	11.37	2479.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		54.	$ 218.		$ 2479.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 818.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 218.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2479.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .32
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 35.57

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO- 5(B)
SYSTEM MODIFICATION: VARIABLE SPEED DRIVE FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO-5, install two-speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	42,802	--	146
ECO	--	21,627	--	74
Savings (Baseline-ECO)	0	21,175	0	72

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 72 MMBtu/Yr X $4.0141 /MMBtu = $290 per year

Nat. Gas: 0 MMBtu/Yr X $2.92 /MMBtu = $0 per year

Total Energy Cost Savings: $290 + $0 = $290 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $425 per year

Total: $0 - $425 = ($425) per year

[ECO-SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input (part 7). The control sequence is:

- 0-50% load, fan 1, half speed cycling.
- 50-100% load, fan 1 full speed cycling.

kWh per bin, for % design loads less than 50% load = (fan 1 power kW) * 14% * (%design load / 50) * 4 hours per bin * days per month.

kWh per bin, for % design loads 50% to 100% load = (fan 1 power kW * ((% design load)/ 100) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 5900 (COOLING TOWER 1 ONLY)	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	78
– WATER FLOW (gpm)	1200
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	4980
HEAT REJECTION CAPACITY (Btu/min)	99600
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	41.58
TOTAL ENTHALPY	61.58
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	75198
MOTOR DATA	
– FAN 1 POWER (kW)	19.2
– FAN 2 POWER (kW)	0
– FAN 3 POWER (kW)	0
– FAN 4 POWER (kW)	0

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET–BULB AVERAGES (4 hour bins)						DESIGN
	1–4	5–8	9–12	13–16	17–20	21–24	WB
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	78
MAY	57.1	56.6	61.2	63.9	63	59.4	78
JUNE	66.8	66.6	69.9	71	70.5	68.2	78
JULY	70.8	70.9	74.5	76	74.9	72.6	78
AUGUST	66.9	67	71	72	71	68.5	78
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	78
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	78

	ENTHALPY FOR AVERAGE WET-BULBS						DESIGN
	1-4	5-8	9-12	13-16	17-20	21-24	ENTHALPY
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	41.58
MAY	24.53	24.21	27.28	29.23	28.57	26.06	41.58
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	41.58
JULY	34.77	34.86	38.14	39.57	38.52	36.37	41.58
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	41.58
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	41.58
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	41.58

	COOLING PROFILE OF CENTRAL PLANTS						PEAK LOAD
	1-4	5-8	9-12	13-16	17-20	21-24	(Btuh)
APRIL	0	0	0	0	0	0	0
MAY	0.9	0.9	0.9	0.9	0.9	0.9	15953000
JUNE	0.9	0.9	0.9	0.9	0.9	0.9	19533000
JULY	0.9	0.9	0.9	0.9	0.9	0.9	19533000
AUGUST	0.9	0.9	0.9	0.9	0.9	0.9	19533000
SEPTEMBER	0.9	0.9	0.9	0.9	0.9	0.9	19533000
OCTOBER	0	0	0	0	0	0	0

	RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY						DAYS PER
	1-4	5-8	9-12	13-16	17-20	21-24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	1.9	1.9	1.7	1.6	1.7	1.8	31
JUNE	1.5	1.5	1.4	1.3	1.4	1.4	30
JULY	1.3	1.3	1.2	1.1	1.2	1.3	31
AUGUST	1.5	1.5	1.3	1.3	1.3	1.4	31
SEPTEMBER	1.6	1.6	1.5	1.4	1.5	1.6	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	% DESIGN LOAD						DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	39.7	39.3	42.9	45.4	44.5	41.4	31
JUNE	59.8	59.5	65.3	67.6	66.5	62.1	30
JULY	67.1	67.4	76.8	81.8	78.1	71.4	31
AUGUST	59.9	60.1	67.6	69.9	67.6	62.6	31
SEPTEMBER	57.2	57.0	61.4	63.2	60.7	58.0	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	SINGLE SPEED CONTROL (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	945	937	1020	1082	1060	985	
JUNE	1377	1370	1504	1557	1532	1431	
JULY	1598	1604	1828	1947	1858	1700	
AUGUST	1427	1430	1609	1664	1609	1491	
SEPTEMBER	1319	1312	1414	1456	1399	1335	
OCTOBER	0	0	0	0	0	0	
TOTAL	6666	6653	7376	7706	7459	6942	42802

	TWO SPEED CONTROL (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	265	262	286	303	297	276	
JUNE	773	759	1027	1133	1083	880	
JULY	1149	1160	1609	1847	1669	1352	
AUGUST	806	813	1171	1281	1171	935	
SEPTEMBER	656	643	847	930	816	689	
OCTOBER	0	0	0	0	0	0	
TOTAL	3649	3638	4939	5494	5036	4132	26887

VARIABLE SPEED COOLING TOWER CYCLING (kWh)							TOTAL (kWh)
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	0	0	0	0	0	0	
MAY	186	181	234	279	263	211	
JUNE	615	606	801	889	847	689	
JULY	901	910	1348	1628	1415	1083	
AUGUST	640	645	919	1017	919	731	
SEPTEMBER	540	532	666	726	644	561	
OCTOBER	0	0	0	0	0	0	
TOTAL	2882	2874	3968	4539	4088	3275	21627

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO BLDG. 5900	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
VARIABLE SPEED COOLING TOWER TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
VFD FOR ONE 25 HP MOTOR	1	EA	4.0	4.0	20	78			4000.00	4000.00	$4,078		
VFD WIRING & CONNECTION	1	LS	4.1	4.1	20	80			20.00	20.00	$100		
WATER TEMPERATURE SENSOR	1	EA	9.0	9.0	20	176			328.00	328.00	$504		
SUBTOTAL						$334				$4,348	$4,682		
OVERHEAD, BOND	16%					$53				$696	$749		
PROFIT	10%					$33				$435	$468		
COST SUB-TOTAL						$421				$5,478	$5,900		
CONTINGENCY	20%					$84				$1,096	$1,180		
SUBTOTAL						$505				$6,574	$7,079		
S&A	5.5%					$28				$362	$389		
TOTAL THIS SHEET						$533				$6,936	$7,469		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: 5900EC5B
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA — REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	7079.
B. SIOH	$	390.
C. DESIGN COST	$	425.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	7105.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	7105.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	72.	$ 290.	11.37	3298.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		72.	$ 290.		$ 3298.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) — $ -425.
(1) DISCOUNT FACTOR (TABLE A) — 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) — $ -4951.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -4951.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1088.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -135.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -1653.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.23
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -52.66

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO-6
SYSTEM MODIFICATION: HIGH EFFICIENCY MOTOR REPLACEMENT
SYSTEMS TO MODIFY: PUMP & COOLING TOWER MOTORS

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO–6, install high efficiency motors.
It was estimated that the electrical energy can be saved by installing high efficiency motors based on the motor operating hours per year.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	28	42,400	0	145

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	145 MMBtu/Yr	X	$4.0141 /MMBtu	=	$581 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$581**	+	**$0**	=	**$581 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 28 kW/month X $1.787 /kW X 12 months/year

= (+) $600 per year

Maintenance: = (-) $0 per year

Total: **$600** - **$0** = **$600 per year**

[ECO-SHT.WK3]

HIGH EFFICIENCY MOTOR REPLACEMENT

LABOR RATE:	19.6	$/hr
ELECTRIC CONS.	0.0137	$/kWH
ELECTRIC DEMAND	1.787	$/kW

BLDG. NO.	EQUIPMENT SERVE	MOTOR HP	MOTOR FLA	MEAS AMPS	MEAS PF	MEAS VOLT	EXST EFF	NEW EFF	KW SVGS	HRS/ YEAR	KWH/YR SVGS	SVGS/ YEAR
5900	CWP-1	50.0	62.5	60	0.82	460	91.35%	93.00%	0.76	3672	2800	$55
	CWP-2	60.0	69	53.6	0.88	460	92.52%	94.50%	0.85	2215	1884	$44
	CWP-3	60.0	75	62	0.83	460	89.92%	94.50%	2.22	810	1796	$72
	CWP-4	75.0	93	82.3	0.87	460	86.79%	93.60%	4.78	419	2003	$130
	CWP-5	60.0	77	67	0.80	460	91.43%	94.50%	1.51	84	127	$34
	CNWP-1	25.0	32	26.3	0.82	460	89.42%	91.70%	0.48	3672	1746	$34
	CNWP-2	30.0	39.8	35.6	0.78	460	90.25%	92.40%	0.57	2215	1266	$30
	CNWP-3	30.0	38	35.6	0.82	460	89.71%	92.40%	0.76	810	615	$25
	CNWP-4	40.0	52	42.9	0.78	460	92.34%	93.00%	0.21	419	86	$6
	CNWP-5	30.0	38	32	0.83	460	89.06%	92.40%	0.86	84	72	$19
	CTM-1	25.0	31	27.2	0.87	460	86.79%	91.70%	1.16	2229	2592	$60
	CTM-2	NI	NI	NI								
	CTM-3	NI	NI	NI								
	CTM-4	NI	NI	NI								
	CTM-5	20.0	24	24.6	0.87	460	89.69%	91.00%	0.27	84	23	$6
	HWP(ret)-1	2.0	6.2	5.6	0.87	230	69.43%	84.00%	0.48	3624	1757	$34
	HWP(ret)-2	2.0	6.2	5.4	0.87	230	69.43%	84.00%	0.47	3624	1694	$33
	HWP(ret)-3	2.0	6.2	5.5	0.87	230	69.43%	84.00%	0.48	3443	1639	$33
	HWP(ret)-4	2.0	6.2	5.3	0.87	230	69.43%	84.00%	0.46	2445	1122	$25
	HWP(ret)-5	2.0	6.3	5.4	0.87	460	34.17%	84.00%	6.50	1720	11179	$293
	HWP(sup)-6	2.0	6.2	5.5	0.87	230	69.43%	84.00%	0.48	910	433	$16
	HWP(sup)-7	15.0	19.8	16.7	0.87	460	81.53%	90.20%	1.36	3624	4945	$97
	HWP(sup)-8	20.0	24	15.2	0.87	460	89.69%	91.00%	0.17	2174.4	369	$9
	HWP(sup)-9	20.0	25	15.6	0.86	460	87.51%	91.00%	0.47	2174.4	1015	$24
	HWP(sup)-10	15.0	19.8	16.7	0.79	460	89.79%	90.20%	0.05	1449.6	77	$[illegible]
	HWP(sup)-11	25.0	30	29	0.93	460	83.90%	91.70%	2.18	1449.6	3158	$9[illegible]
		DEMAND CREDIT		**$590**	**MMBtu**	**145**		**TOTAL**	**28**		**42400**	**$1,171**
6003	CWP-1	NI	NI	NI								
	CWP-2	50.0	62.5	44.6	0.81	460	92.48%	93.00%	0.18	3672	645	$13
	CWP-3	50.0	62.5	46.4	0.87	460	86.10%	93.00%	2.77	3672	10181	$199
	CNWP-1	NI	NI	NI								
	CNWP-2	30.0	37	32	0.84	460	90.38%	92.40%	0.52	3672	1905	$37
	CNWP-3	30.0	37	31	0.87	460	87.26%	92.40%	1.37	3672	5029	$98
	CTM-1	50.0	63	56.3	0.87	460	85.41%	93.00%	3.73	1087	4051	$135
	CTM-2	50.0	63	56.3	0.87	460	85.41%	93.00%	3.73	1087	4051	$135
		DEMAND CREDIT		**$264**	**MMBtu**	**88**		**TOTAL**	**12**		**25861**	**$618**

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 10-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CODE A [X] CODE B [ ] CODE C

OTHER

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

MOTOR REP. ECO BLDG. 5900		Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
HIGH EFF. MOTOR REP.LACEMENT TASK DESCRIPTION		No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CWP-1	50.0 HP MOTOR	1	EA	9.0	9.0	20	176			2579.0	2579.00	$2,755		
CWP-2	60.0 HP MOTOR	1	EA	10.3	10.3	20	201			3235.0	3235.00	$3,436		
CWP-3	60.0 HP MOTOR	1	EA	10.3	10.3	20	201			3235.0	3235.00	$3,436		
CWP-4	75.0 HP MOTOR	1	EA	12.0	12.0	20	235			3853.0	3853.00	$4,088		
CWP-5	60.0 HP MOTOR	1	EA	10.3	10.3	20	201			3235.0	3235.00	$3,436		
CNWP-1	25.0 HP MOTOR	1	EA	5.8	5.8	20	113			1396.0	1396.00	$1,509		
CNWP-2	30.0 HP MOTOR	1	EA	6.0	6.0	20	117			1639.0	1639.00	$1,756		
CNWP-3	30.0 HP MOTOR	1	EA	6.0	6.0	20	117			1639.0	1639.00	$1,756		
CNWP-4	40.0 HP MOTOR	1	EA	7.2	7.2	20	141			2212.0	2212.00	$2,353		
CNWP-5	30.0 HP MOTOR	1	EA	6.0	6.0	20	117			1639.0	1639.00	$1,756		
CTM-1	25.0 HP MOTOR	1	EA	5.8	5.8	20	113			1396.0	1396.00	$1,509		
HWP(ret)-1	2.0 HP MOTOR	1	EA	3.2	3.2	20	63			359.0	359.00	$422		
HWP(ret)-2	2.0 HP MOTOR	1	EA	3.2	3.2	20	63			359.0	359.00	$422		
HWP(ret)-3	2.0 HP MOTOR	1	EA	3.2	3.2	20	63			359.0	359.00	$422		
HWP(ret)-4	2.0 HP MOTOR	1	EA	3.2	3.2	20	63			359.0	359.00	$422		
HWP(ret)-5	2.0 HP MOTOR	1	EA	3.2	3.2	20	63			359.0	359.00	$422		
HWP(sup)-6	2.0 HP MOTOR	1	EA	3.2	3.2	20	63			359.0	359.00	$422		
HWP(sup)-7	15.0 HP MOTOR	1	EA	4.5	4.5	20	88			985.0	985.00	$1,073		
HWP(sup)-8	20.0 HP MOTOR	1	EA	5.5	5.5	20	109			1189.0	1189.00	$1,298		
HWP(sup)-9	20.0 HP MOTOR	1	EA	5.5	5.5	20	109			1189.0	1189.00	$1,298		
HWP(sup)-10	15.0 HP MOTOR	1	EA	4.5	4.5	20	88			985.0	985.00	$1,073		
HWP(sup)-11	25.0 HP MOTOR	1	EA	5.8	5.8	20	113			1396.0	1396.00	$1,509		
SUBTOTAL							$2,619				$33,956	$36,575		
OVERHEAD, BOND		16%					$419				$5,433	$5,852		
PROFIT		10%					$262				$3,396	$3,657		
COST SUB-TOTAL							$3,300				$42,785	$46,084		
CONTINGENCY		20%					$660				$8,557	$9,217		
SUBTOTAL							$3,960				$51,341	$55,301		
S&A		5.5%					$218				$2,824	$3,042		
TOTAL THIS SHEET							$4,177				$54,165	$58,343		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5900EC6
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: HIGH EFF. MOTOR
ANALYSIS DATE: 04-10-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	55301.
B. SIOH	$	3042.
C. DESIGN COST	$	3318.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	55495.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	55495.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	145.	$ 581.	11.37	6604.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		145.	$ 581.		$ 6604.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 600.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 6990.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 6990.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 2179.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .16
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 1181.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 13594.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .24
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 47.00

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO- 7
SYSTEM MODIFICATION: INSTALL INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-7, install instrumentation to facilitate efficient operation of boiler plant. It was estimated that the energy wasted from boiler in standby is 1% of the rated output capacity. The hours when boilers are running unnecessary were estimated for each boiler.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	0	0	161	161

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	161 MMBtu/Yr	X	$2.92 /MMBtu	=	$470 per year
Total Energy Cost Savings:	**$0**	+	**$470**	=	**$470 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $306 per year

Total: $0 - $306 = ($306) per year

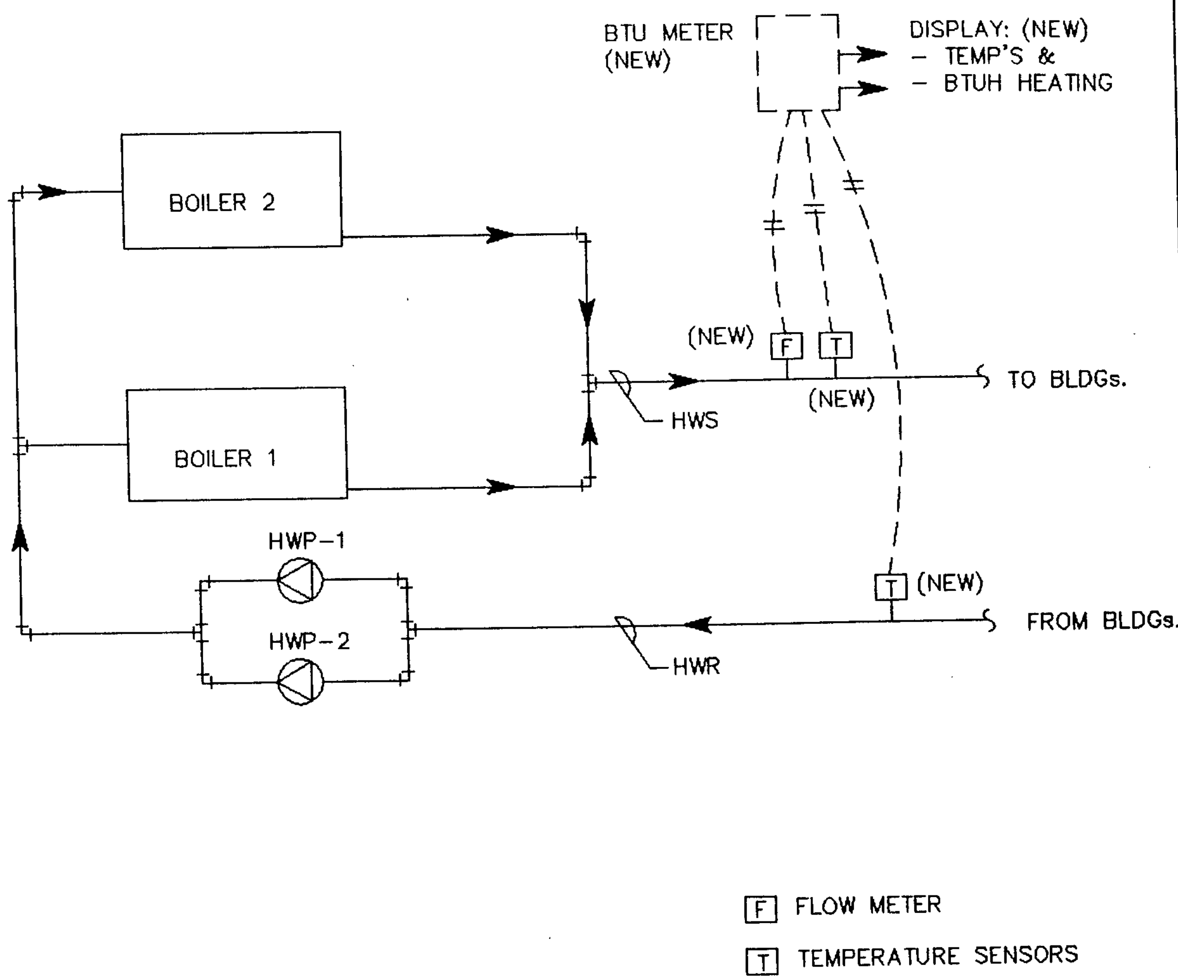
[ECO-SHT.WK3]

BOILER STANDBY SAVINGS

CENTRAL PLANT	BOILER NO.	BOILER TYPE	BOILER MANUFACTURERER	BOILER MODEL NUMBER	RATED BOILER OUTPUT MMBTU/H	CALC. BOILER OUTPUT MMBTU/H	STANDBY LOSS (1%) MMBTU/H	EXCESS STANDBY (HRS/YR)	EXCESS STANDBY MMBTU/H	EXCESS STANDBY SAVINGS ($)
5900	1	HTHW	INTERNATIONAL	D-12	10.00	6.94	0.0694	0		
	2	HTHW	INTERNATIONAL	D-12	10.00	7.17	0.0717	720	51.62	$150.74
	3	HTHW	HERCULES	300	9.70	7.61	0.0761	720	54.82	$160.09
	4	HTHW	HERCULES	300	9.70	7.58	0.0758	720	54.55	$159.27
	5	HTHW	INTERNATIONAL	1035 TH12	8.00	6.22	0.0622	0		
	6	HTHW	INTERNATIONAL	TJW-C-10	11.20	8.88	0.0888	0		
						TOTAL		2160	160.99	$470.10
6003	1	STEAM-12	KEWANEE	L39-350-605	11.72	9.41	0.0941	0		
	2	STEAM-12	YORK SHIPLEY	SPL-350-112080	11.72	9.12	0.0912	0		
	3	STEAM-12	KEWANEE	L36-350-605	11.72	9.37	0.0937	720	67.45	$196.96
						TOTAL		720	67.45	$196.96
730	1	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	0		
	2	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	720	44.34	$129.47
	3	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.18	0.0618	720	44.51	$129.96
	4	STEAM-12	KEWANEE	CAT#7L280-KG-06	2.66	2.11	0.0211	0		
						TOTAL		1440	88.84	$259.43
2812	1	STEAM-12	FEDERAL BOILER CO	GS 3562	1.80	1.40	0.0140	0		
	2	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.77	0.0277	0		
	3	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.86	0.0286	720	20.62	$60.21
						TOTAL		720	20.62	$60.21
5676	1	HW	AMERICAN STANDARD	PF 515	2.44	1.80	0.0180	720	12.93	$37.76
	2	HW	AMERICAN STANDARD	PF 515	2.44	1.71	0.0171	0		
						TOTAL		720	12.93	$37.76
5678	1	HW	BRUNHAM	PF 514	2.27	1.50	0.0150	720	10.79	$31.50
	2	HW	BRUNHAM	PF 514	2.27	1.63	0.0163	0		
						TOTAL		720	10.79	$31.50
914	1	STEAM-12	BRUNHAM	PF-510	1.61	1.29	0.0129	0		
	2	HW	RAY-PAK	EA 200ITB	1.61	1.22	0.0122	0		
	3	HW	AMERICAN STANDARD	G1015	1.92	1.47	0.0147	720	10.56	$30.84
	4	HW	AMERICAN STANDARD	G1015	1.92	1.40	0.0140	0		
						TOTAL		720	10.56	$30.84
4701	1	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	0		
	2	STEAM-100	BIRCHFIELD	FBH 578	11.00	0.00	0.0000	0		
	3	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	720	60.73	$177.33
						TOTAL		720	60.73	$177.33

[BOILERS.WK3]

ECO-7, INSTRUMENTATION FOR BOILER PLANT
(TYPICAL)



[B-ECO-7.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91 | DATE PREPARED 04-Apr-91

DRAWING NO. | SHT OF

ESTIMATOR KC | CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

BOILER ECO BLDG. 5900 INSTRUMENTATION	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 6 HTHW BOILERS													
HTHWS TEMPERATURE SENSOR	1	EA			176	176			340.00	340.00	$516		
HTHWR TEMPERATURE SENSOR	1	EA			176	176			340.00	340.00	$516		
ORIFICE INSERT TYPE	1	EA	5.2	5.2	20	102			290.00	290.00	$392		
FLOW TRANSDUCER	1	EA	5.2	5.2	20	102			290.00	290.00	$392		
BTU METER	1	EA	6.0	6.0	20	118			820.00	820.00	$938		
LED DISPLAY	2	EA							60.00	120.00	$120		
LED INSTALLATION	2	EA	4.6	9.2	19.6	180.32			158	316	496.32		
SUBTOTAL						$855				$2,516	$3,371		
OVERHEAD, BOND	16%					$137				$403	$539		
PROFIT	10%					$85				$252	$337		
COST SUB-TOTAL						$1,077				$3,170	$4,247		
CONTINGENCY	20%					$215				$634	$849		
SUBTOTAL						$1,292				$3,804	$5,096		
S&A	5.5%					$71				$209	$280		
TOTAL [illegible]IS SHEET						$1,363				$4,013	$5,377		

DA FORM[illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: B5900E12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER INSTRUMENTATION
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	5096.
B. SIOH	$	281.
C. DESIGN COST	$	306.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	5115.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	5115.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	161.	$ 470.	12.48	5867.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		161.	$ 470.		$ 5867.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -306.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -2788.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -2788.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1936.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 164.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 3079.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .60
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 31.16

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO-8
SYSTEM MODIFICATION: BOILER OPTIMIZATION, CONTROL & INSTRUMENTATION
SYSTEMS TO MODIFY: BOILER 1 THROUGH 6

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-8, install instrumentation connected to EMCS for boiler optimization.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

	Electric		Nat. Gas	Total Energy
PC CUBE RUN	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	--	172,255	172,255
ECO	--	--	166,098	166,098
Savings (Baseline-ECO)	0	0	6,157	6,157

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	6157 MMBtu/Yr	X	$2.92 /MMBtu	=	$17,978 per year
Total Energy Cost Savings:	**$0** +		**$17,978**	=	**$17,978 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $2,745 per year

Total: **$0** - **$2,745** = **($2,745) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	172256.
PEAK DAY GAS CONSUMP., 1000 CU FT	1663.
ELECTRICAL CONSUMPTION, KWH	2224028.
PEAK KW DEMAND (15 MIN BASIS)	1886.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2224028.
ON-PEAK KW DEMAND (15 MIN BASIS)	1886.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	84
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3443
BOILER 4	2445
BOILER 5	1720
BOILER 6	910
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Total additional annual energy use due to operating chillers 3, 4, and 5 more than necessary: 519,104 kWh/yr

Total electrical consumption: 2,743,132 kWh/yr

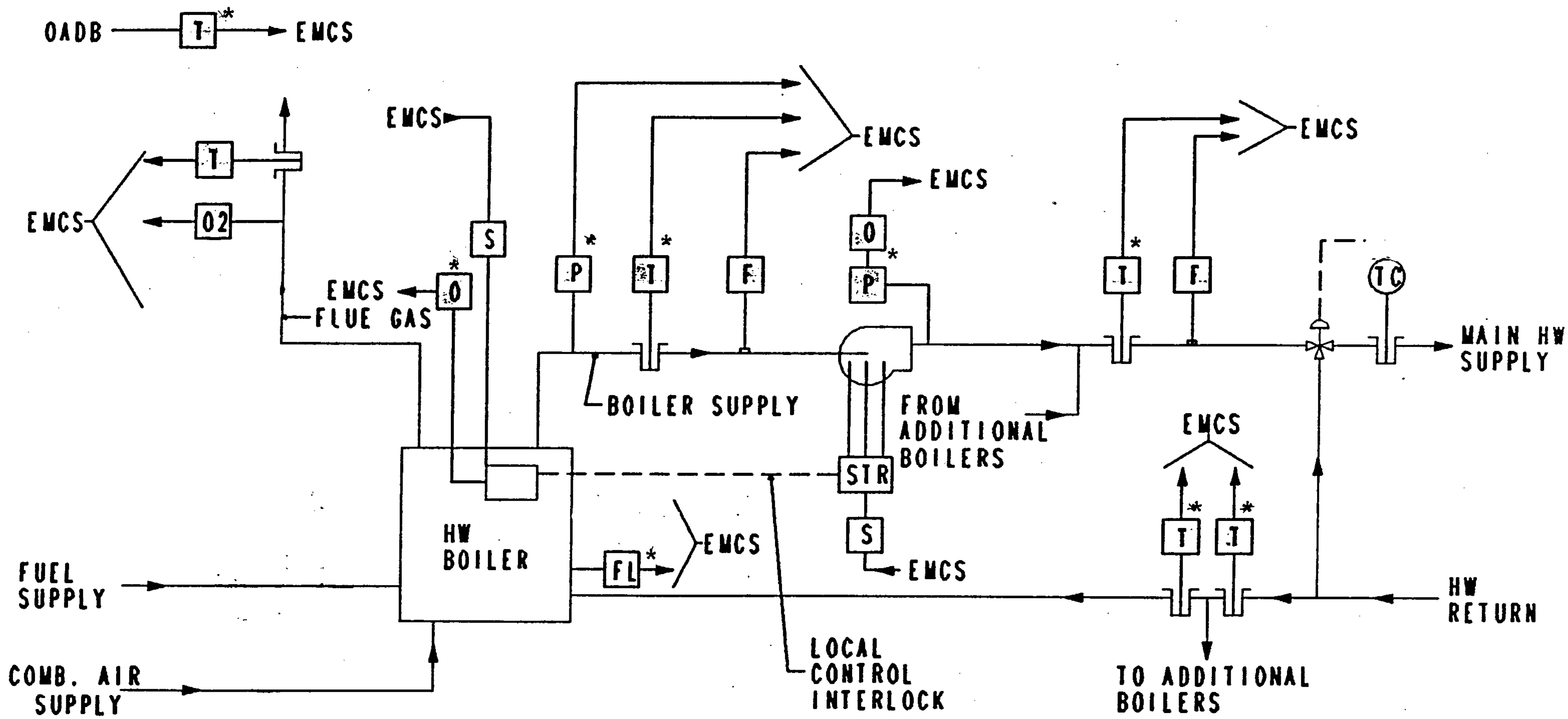
PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER ECO-2

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

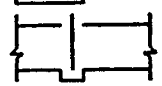
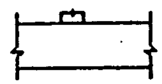
FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	166098.
PEAK DAY GAS CONSUMP., 1000 CU FT	1642.
ELECTRICAL CONSUMPTION, KWH	2213589.
PEAK KW DEMAND (15 MIN BASIS)	1874.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2213589.
ON-PEAK KW DEMAND (15 MIN BASIS)	1874.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	101
CHILLER 6	0
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3311
BOILER 4	2392
BOILER 5	1678
BOILER 6	745
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.



Hot water boiler

* - Points included on proposed EMCS design, existing.
All other points are new.

→ EMCS	SIGNAL TRANSMITTED TO EMCS
← EMCS	SIGNAL TRANSMITTED FROM EMCS
A	ALARM CONTACT SIGNAL
E	ECONOMIZER CONTROL INTERFACE
F	FLOW INDICATION
FI	FLAME INDICATION
H	HUMIDITY INDICATION
P	PRESSURE INDICATION
LV	LEVEL INDICATION
M	METER
O	ON-OFF STATUS SIGNAL
DP	DIFFERENTIAL PRESSURE SWITCH
R	CONTROLLER RESET INTERFACE
S	START-STOP INTERFACE
T	TEMPERATURE INDICATION
V	VENTILATION/RECIRCULATION CONTROL
PS	POSITION
O_2	FLUE GAS ANALYSIS, OXYGEN
Co	FLUE GAS ANALYSIS, CARBON MONOXIDE

FD	FURNACE DRAFT DIFFERENTIAL PRESSURE
DS	HIGH-LOW DEMAND SIGNAL SELECTOR
TC	TEMPERATURE CONTROLLER
PC	PRESSURE CONTROLLER
STR	MOTOR STARTER
	SENSOR INSTALLED IN THERMOMETER WELL
	SENSOR INSTALLED IN DUCT OR PLENUM
CHW	CHILLED WATER
EA	EXHAUST AIR
SA	SUPPLY AIR
RA	RETURN AIR
OA	OUTSIDE AIR
MA	MIXED AIR
WB	WET BULB
DB	DRY BULB
OAD	OUTSIDE AIR DAMPER
RAD	RETURN AIR DAMPER
EAD	EXHAUST AIR DAMPER
MZD	MULTIZONE DAMPER
RH	RELATIVE HUMIDITY

Symbols and Abbreviations

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C

OTHER ________

EFFECTIVE PRICING DATE APR. 91

DRAWING NO.

DATE PREPARED 12-Apr-91

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

BOILER ECO BLDG. 5900	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
OPTIMIZE BOILER SEQUENCE / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 2 HW BOILERS													
HWS TEMPERATURE SENSOR *	6	EA			176	$1,056			$328	$1,968	$4,992		
HWR TEMPERATURE SENSOR *	6	EA			176	$1,056			$328	$1,968	$4,992		
HWP ST/SP	11	LS			39	$431			$226	$2,486	$2,917		
DP (LIQUID) PUMP STATUS *	11	LS			155	$1,705			$205	$2,255	$6,215		
BOILER ST/SP	6	EA	2.0	12.0	20	$235			$226	$1,356	$1,591		
FID PANEL & ACCESSORIES *	1	LS			208	$208			$3,681	$3,681	$7,570		
FID SOFTWARE COMMISSIONING	1	EA	6.0	6.0	45	$270					$270		
FID TESTING	1	EA	6.0	6.0	45	$270					$270		
INST. FLOW METER	1	EA	3.5	3.5	20	$69			500	$500	$569		
STACK O2 SENSOR	6	LS			338	$2,028			$3,483	$20,898	$22,926		
STACK TEMP. SENSOR	6	EA	4.0	24.0	20	$470			$207	$1,239	$1,709		
CREDIT FROM EMCS PROJECT *						($4,025)				($9,872)	($13,897)		
SUBTOTAL						$3,773				$26,479	$30,252		
OVERHEAD, BOND	16.0%					$604				$4,237	$4,840		
PROFIT	10.0%					$377				$2,648	$3,025		
COST SUB-TOTAL						$4,754				$33,364	$38,118		
CONTINGENCY	20.0%					$951				$6,673	$7,624		
SUBTOTAL						$5,705				$40,036	$45,742		
S&A	5.5%					$314				$2,202	$2,516		
TOTAL THIS SHEET						$6,019				$42,238	$48,257		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: B5900E12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER OPTIMIZATION
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	45742.
B. SIOH	$	2516.
C. DESIGN COST	$	2745.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	45903.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	45903.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	6157.	$ 17978.	12.48	224371.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		6157.	$ 17978.		$ 224371.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -2745.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -25007.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -25007.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 74042.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 15233.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 199364.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 4.34
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 3.01

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO-9
SYSTEM MODIFICATION: RENOVATE BOILER
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:

Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-9, renovate or replace existing boilers.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	172,255	172,255
ECO	--	--	165,014	165,014
Savings (Baseline-ECO)	0	0	7,241	7,241

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	7241 MMBtu/Yr	X	$2.92 /MMBtu	=	$21,144 per year
Total Energy Cost Savings:	**$0**	**+**	**$21,144**	**=**	**$21,144 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $1,792 per year

Total: $0 - $1,792 = ($1,792) per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	172256.
PEAK DAY GAS CONSUMP., 1000 CU FT	1663.
ELECTRICAL CONSUMPTION, KWH	2224028.
PEAK KW DEMAND (15 MIN BASIS)	1886.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2224028.
ON-PEAK KW DEMAND (15 MIN BASIS)	1886.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	84
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3443
BOILER 4	2445
BOILER 5	1720
BOILER 6	910
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Total additional annual energy use due to operating chillers 3, 4, and 5 more than necessary: 519,104 kWh/yr

Total electrical consumption: 2,743,132 kWh/yr

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER ECO-3

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	165014.
PEAK DAY GAS CONSUMP., 1000 CU FT	1616.
ELECTRICAL CONSUMPTION, KWH	2213589.
PEAK KW DEMAND (15 MIN BASIS)	1874.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2213589.
ON-PEAK KW DEMAND (15 MIN BASIS)	1874.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	101
CHILLER 6	0
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3311
BOILER 4	2349
BOILER 5	1613
BOILER 6	795
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ________

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 12-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

BOILER ECO BLDG. 5900	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
BOILER RENOVATION / TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
RENOVATION OF BOILER 1 AND 2													
CLEAN TUBES	2	EA	16.0	32.0	24	$768					$768		
REBUILD REFACTORY	2	EA	40.0	80.0	24	$1,920					$1,920		
NEW INSULATION	2	LS							$1,920	$3,840	$3,840		
ADJUST CONTROLS	2	EA	6.7	13.3	24	$320					$320		
ACIDIZING	2	EA	6.7	13.3	24	$320					$320		
CLEAN ADJUST BURNERS	2	EA	4.0	8.0	24	$192					$192		
TEST BOILERS	2	EA	4.0	8.0	24	$192					$192		
NEW INSTRUMENTS	2	LS							$200	$400	$400		
ANNUAL RECURRING COST													
CLEAN TUBES	2	EA	16.0	32.0	24	$768					$768		
ADJUST CONTROLS	2	EA	6.7	13.3	24	$320					$320		
ACIDIZING	2	EA	6.7	13.3	24	$320					$320		
CLEAN ADJUST BURNERS	2	EA	4.0	8.0	24	$192					$192		
TEST BOILERS	2	EA	4.0	8.0	24	$192					$192		
TOTAL											$1,792		
SUBTOTAL						$3,712				$4,240	$7,952		
OVERHEAD, BOND	16.0%					$594				$678	$1,272		
PROFIT	10.0%					$371				$424	$795		
COST SUB-TOTAL						$4,677				$5,342	$10,020		
CONTINGENCY	20.0%					$935				$1,068	$2,004		
SUBTOTAL						$5,613				$6,411	$12,023		
S&A	5.5%					$309				$353	$661		
TOTAL THIS SHEET (WO/ANNUAL RECC. COST)						$5,921				$6,763	$12,685		

DA FORM [illegible], APR 85

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: B5900EC3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER RENOVATION
ANALYSIS DATE: 04-09-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	12023.
B. SIOH	$	662.
C. DESIGN COST	$	722.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	12066.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	12066.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	7241.	$ 21144.	12.48	263874.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		7241.	$ 21144.		$ 263874.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1792.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -16325.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -16325.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 87078.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 19352.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 247549.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 20.52
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 .62

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO-10
SYSTEM MODIFICATION: OXYGEN TRIM FOR BURNERS
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-10, install oxygen trim for burners.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	--	172,255	172,255
ECO	--	--	169,073	169,073
Savings (Baseline-ECO)	0	0	3,182	3,182

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	3182 MMBtu/Yr	X	$2.92 /MMBtu	=	$9,291 per year
Total Energy Cost Savings:	**$0**	+	**$9,291**	=	**$9,291 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $4,247 per year

Total: **$0** - **$4,247** = **($4,247) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	172256.
PEAK DAY GAS CONSUMP., 1000 CU FT	1663.
ELECTRICAL CONSUMPTION, KWH	2224028.
PEAK KW DEMAND (15 MIN BASIS)	1886.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2224028.
ON-PEAK KW DEMAND (15 MIN BASIS)	1886.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	84
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3443
BOILER 4	2445
BOILER 5	1720
BOILER 6	910
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Total additional annual energy use due to operating chillers 3, 4, and 5 more than necessary: 519,104 kWh/yr
Total electrical consumption: 2,743,132 kWh/yr

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BOILER ECO-4

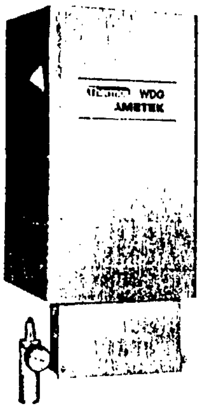
** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	168871.
PEAK DAY GAS CONSUMP., 1000 CU FT	1636.
ELECTRICAL CONSUMPTION, KWH	2213589.
PEAK KW DEMAND (15 MIN BASIS)	1874.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2213589.
ON-PEAK KW DEMAND (15 MIN BASIS)	1874.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	101
CHILLER 6	0
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3407
BOILER 4	2392
BOILER 5	1660
BOILER 6	851
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

SPECIFICATIONS – AIR-MIZER II SYSTEM

SENSOR



Nominal Dimensions: 14⅝"H x 10¼"W x 10"D (37.2 x 26 x 25.4 cm)

Enclosure: Weather resistant—S.S. case, nickel plated carbon steel base

Weight: 55 pounds (25 kg)

Accuracy: ±1% of net excess oxygen

Repeatability: ±0.2% of measured value

Response: 90% of full scale in less than 5 seconds

Drift: Less than 0.1% of sensor cell output per month

Ambient Temperatures: –5 to +175°F (–20.5 to +79°C)

Sample Temperatures: Up to 1300°F (704°C) with standard probe

Sample Flow Rate: 0.1 to 120 scfh (0.47 to 56.65 liters/minute)

Air Aspirator Requirements: 10 to 20 scfh (4.72 to 14.16 liters/ min) at 15-100 psi (1.05 to 7.037 kg/cm²) (Aspirator air regulator furnished with sensor normally set at 2-7 psi; 0.14 - 0.49 kg/cm²)

Calibration: With analyzed oxygen in nitrogen sample. Calibration port provided.

CONTROL UNIT

Nominal Dimensions: 12⅝"H x 10⅞"W x 9⅛"D (32.1 x 27.6 x 23.2 cm)

Enclosure: Wall/panel mounted—meets the requirements for NEMA 4 areas

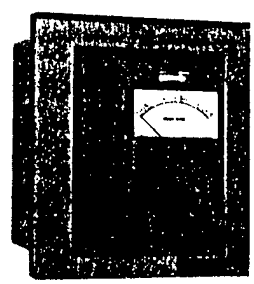
Weight: 22 pounds (10 kg)

Temperature Control: On-Off by microprocessor (±1°C)

Linearization: 256 segments from 20% to 0.2% O_2, (218 from 10% to 0.2%), by microprocessor

Controller Action: On-Off—"On" time adjustable 2-20 seconds. "Off" time adjustable 2-60 seconds.
Deadband: ± 0.25% oxygen.
LED's indicate motor driving.
Will not allow decrease in air when O_2 is below 0.5% oxygen. Air flow will increase to +15% max. If O_2 level is above 12%.

Setpoint: 0 to 10% oxygen by either of: A. Two banks of 5 slide pots, (Dual Fuel) selectable by slide switch; proper pot or pots connected to processor by switch in actuator. B. Manual pot on panel A or B selected by Remote/Local switch on panel. Setpoint indicated by edge reading meter (0-10%)



Manual Control: Manual/Auto switch and increase—decrease push buttons (Spring return switch inside control unit can override all control actions in the event of processor failure).

Ready Indicator: On at temperature set point. Off below temperature set point. Flashes above temperature set point. O_2 Control in "manual" when below set point.

Oxygen Scale: 20.9 to 0.1% O_2 Logarithmic

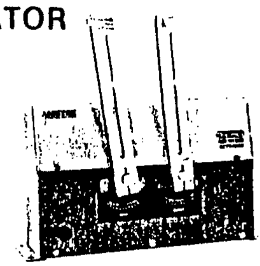
Alarms: High and Low O_2 adjustable 0.2 to 20%. RTD Failure (shuts down temperature control, and puts O_2 control in "manual").

Increase Air Override: Contact closure from optional combustibles or smoke detector alarm will cause increase in air signal on each control pulse regardless or O_2 vs. O_2 setpoint relationship. Once combustibles contact opens, normal control will resume. This maintains air flow at a level where maximum allowable combustibles or smoke is not exceeded.

Ambient Temperature Limits: 32°F to 140°F (0 to +60°C)

Recorder Output: 0-100 mv = 0-20% O_2 Linear (0-50 mv = 0-10%) Other current or voltages outputs optional

ACTUATOR



Overall Size: 17½"L x 4"W x 10¼"H (44.5 x 10.2 x 26 cm)

Weight: 16.5 pounds (7.5 kg)

Angular Travel (Input Arm): 60°

Linear Link Travel: Adjustable 4" to 10" at 4" to 10" Radius (10.2 to 25.4 cm at 10.2 to 25.4 cm Radius)

Linear Link Force: 100 pounds at 4" Radius (45.5 kg at 10.2 cm Radius)
70 pounds at 6" Radius (31.8 kg at 15.2 cm Radius)
40 pounds at 10" Radius (18.2 kg at 25.4 cm Radius)

Case: Suitable for areas requiring NEMA 2 equipment (Drip proof indoor)

Correction: –15% to +15% (.85 to 1.15 gain) of normal air flow

Speed: 60 seconds from –15% to +15% correction (max.)

Load Indication: 9 position shorting switch tied to input arm

Brake: Internal brake will hold load at any above rated force without "coasting"

Ambient Temperature Limits: 0°F to 160°F (–18 to +71°C)

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ]

OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

BOILER ECO BLDG. 5900	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
BOILER CONTROL O2 TRIM TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
O2 TRIM CONTROL	6	EA			3000	$18,000			$1,800	$9,590	$27,590		
ANNUAL RECURRING COST													
OXIGEN SENSOR	6	EA	0.5	3.0	24	$72			$420	$2,520	$2,592		
OTHER MAINTENANCE COST	1	LS							$1,655	$1,655	$1,655		
ANNUAL TOTAL											$4,247		
SUBTOTAL						$18,000				$9,590	$27,590		
OVERHEAD, BOND	16.0%					$2,880				$1,534	$4,414		
PROFIT	10.0%					$1,800				$959	$2,759		
COST SUB-TOTAL						$22,680				$12,083	$34,763		
CONTINGENCY	20.0%					$4,536				$2,417	$6,953		
SUBTOTAL						$27,216				$14,500	$41,716		
S&A	5.5%					$1,497				$798	$2,294		
TOTA[illegible]S SHEET						$28,713				$15,298	$44,010		

DA FORM[illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5900EC10
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER O2 TRIM CONTROL
ANALYSIS DATE: 04-10-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	41716.
B. SIOH	$	2295.
C. DESIGN COST	$	2503.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	41863.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	41863.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	3182.	$ 9291.	12.48	115957.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		3182.	$ 9291.		$ 115957.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -4247.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -38690.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -38690.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 38266.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 5044.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 77267.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 1.85
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 8.30

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO-12
SYSTEM MODIFICATION: STACK ECONOMIZERS
SYSTEMS TO MODIFY: BOILER 1 THROUGH 6

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO-12, install stack economizer for boilers.
The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	172,255	172,255
ECO	--	--	165,866	165,866
Savings (Baseline-ECO)	0	0	6,389	6,389

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	6389 MMBtu/Yr	X	$2.92 /MMBtu	=	$18,656 per year
Total Energy Cost Savings:	**$0**	+	**$18,656**	=	**$18,656 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $0 per year

Total: **$0** - **$0** = **$0 per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	172256.
PEAK DAY GAS CONSUMP., 1000 CU FT	1663.
ELECTRICAL CONSUMPTION, KWH	2224028.
PEAK KW DEMAND (15 MIN BASIS)	1886.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2224028.
ON-PEAK KW DEMAND (15 MIN BASIS)	1886.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	84
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3443
BOILER 4	2445
BOILER 5	1720
BOILER 6	910
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Total additional annual energy use due to operating chillers 3, 4, and 5 more than necessary: 519,104 kWh/yr
Total electrical consumption: 2,743,132 kWh/yr

PC-CUBE VERSION 2.0.3

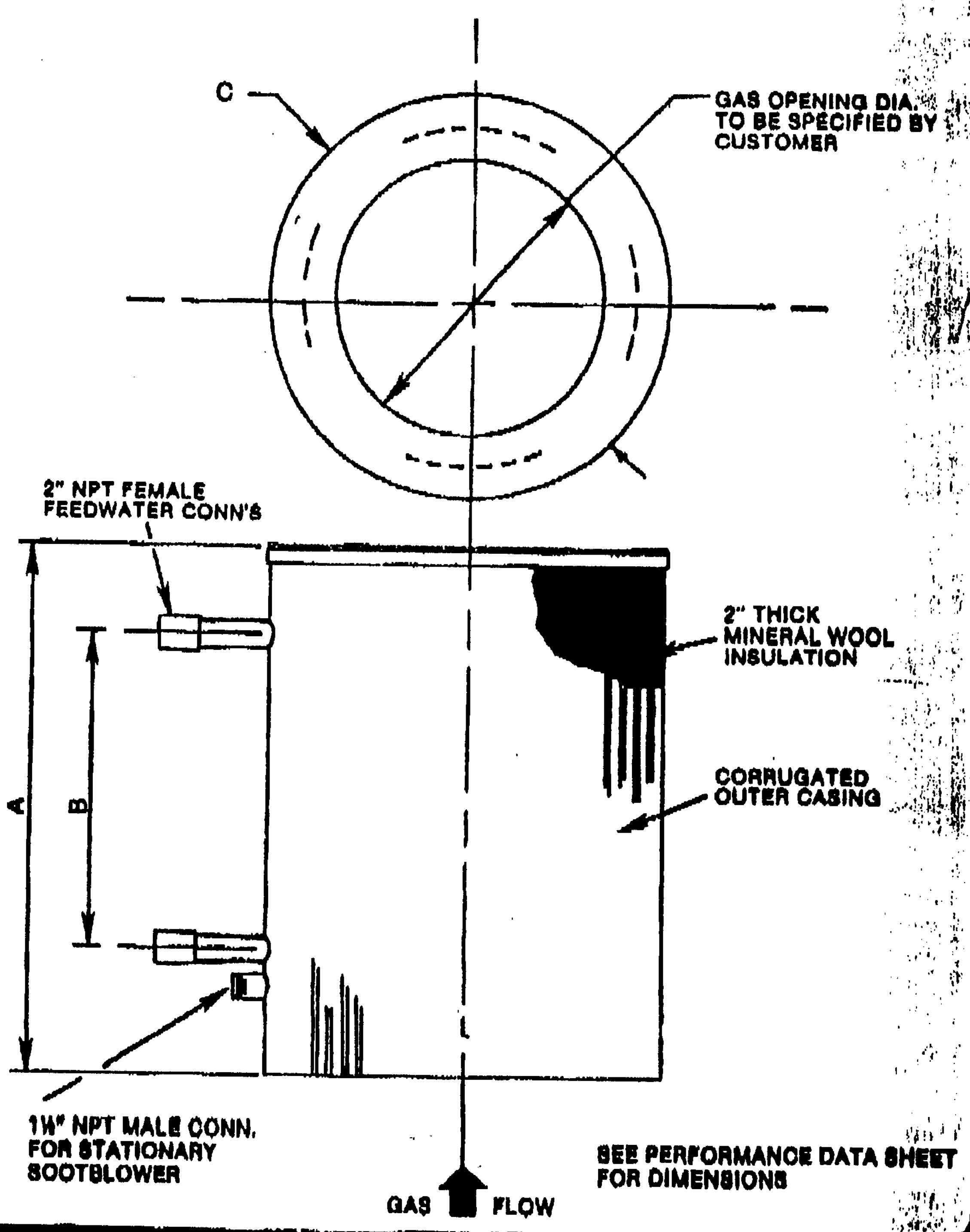
CENTRAL PLANT 5900 BOILER ECO-6

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	165866.
PEAK DAY GAS CONSUMP., 1000 CU FT	1617.
ELECTRICAL CONSUMPTION, KWH	2213589.
PEAK KW DEMAND (15 MIN BASIS)	1874.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2213589.
ON-PEAK KW DEMAND (15 MIN BASIS)	1874.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	101
CHILLER 6	0
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3311
BOILER 4	2368
BOILER 5	1649
BOILER 6	795
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Kentube Cylindrical Fuel Economizer



SEE PERFORMANCE DATA SHEET FOR DIMENSIONS

Kentube
4150 South Elwood • Tulsa, Oklahoma 47107
918/446-4551 • Telex: 49-2353

****Ur I ***

CUSTOMER
EMC Engineers
PROPOSAL 318-10351-0-0
RUN 00

KENTUBE
4150 S. ELWOOD
TULSA, OKLAHOMA

PRINTED 04/10/91
TIME 09 HRS 10 MINS
CUST. REFERENCE

CYLINDRICAL FUEL ECONOMIZER MODEL 100930

OVERALL PERFORMANCE

COUNTER CURRENT FLOW
FLUID CIRCULATED IN TUBES IS WATER

HEAT EXCHANGED	97907.	BTU/HR
U EXTERNAL	4.811	BTU/HR-SQFT-F
LMTD	150.1	DEG F

OVERALL CONSTRUCTION

VERTICAL GAS FLOW
DIMENSIONS

DIM A	(HEIGHT)	5'-3/4"
DIM B	(NOZ C-C)	3'-3 3/8"
DIM C	(DIAMETER)	2'-1 1/2"
DRAWING NO		V- 1

SOOT BLOWERS ARE BUILT IN

NOZZLE SIZE	2.0	IN
SURFACE AREA	134.	SQFT
LIQUID WEIGHT	70.	LB
UNIT WEIGHT(DRY)	742.	LB

PERFORMANCE SPECIFICATIONS

	TUBE SIDE ↓	GAS SIDE ↑	
FLOW RATE	2070.	2474.	LB/HR
TEMP IN	180.0	450.0	DEG F
TEMP OUT	227.2	301.1	DEG F
PRES IN	150.0 PSIG	14.7	PSIA
PRES DROP	.0 PSI	.19	IN WATER

CONSTRUCTION SPECIFICATIONS
TUBE SIDE

DESIGN PRESSURE		490.	PSI
TEST PRESSURE		735.	PSI
DESIGN TEMPERATURE		700.	DEG
TUBE	OUTSIDE DIA	2.000	IN
	MATERIAL	C/STL	
FIN	THICKNESS	.060	IN
	PITCH	3.00	FINS/
	MATERIAL	C/STL	
INSULATION			
	MATERIAL	MINERAL WOO	
	THICKNESS	2.0	IN

Kentube
DIVISION FINTUBE CORPORATION
FABRICATED PRODUCTS

4150 S. Elwood
Tulsa, Oklahoma 74107
Phone: (918) 446-4561
FAX: (918) 446-6340

QUOTATION

TO	EMC Engineers 2750 South Wadsworth Blvd. Denver, CO 80227 Attention: Mr. Dennis Jones

QUOTATION DATE	YOUR REFERENCE	OUR REFERENCE
04/10/91		318-10351-0-0

SHIPPING ESTIMATE	TERMS	PAGE
8 Weeks*	Net 30 Days	PAGE 1 OF 3

SHIPPING DESTINATION	F.O.B.
	Kentube Shop**

THANK YOU FOR YOUR INQUIRY. WE APPRECIATE THE OPPORTUNITY TO PROPOSE THE FOLLOWING:

ITEM	QUANTITY	DESCRIPTION	UNIT AMOUNT	AMOUNT
	4	Kentube RETROMISER Fuel Economizer Cylindrical Model 100930, in accordance with the attached performance specifications. **DESIGN FEATURES** Finned tube unit; 3 Fins per inch; Vertical gas flow; Counter-current flow Fuel type: NATURAL GAS. Estimated Shipping Weight - 742. LBS. Pressure parts to Section I of the ASME Boiler & Pressure Vessel Code. External 2" insulation with weatherproof, corrugated casing is included. Threaded drain and vent connections included. Kentube manually operated sootblower, integral with unit, included. Requires 85 psig to 250 psig supply pressure.	$ 3011.	$ 12044.

ENCLOSURES

cc: Ted D. Miller Associates

NOTE: All shipping estimates are based on "after receipt of order" and "after final print approvals" as required. Shipments can often be improved upon request. Please contact Kentube.
Prices firm for 30 days and subject to change thereafter. No provision is made for Federal, State or Municipal taxes. All orders are subject to acceptance or rejection by the Credit Department of Kentube and to the Terms of Sale attached.

YOUR REPRESENTATIVE IS:	YOUR ORDER WILL RECEIVE OUR PROMPT ATTENTION
✓ Ted D. Miller Associates 2140 South Ivanhoe Denver, CO 80222	KENTUBE FABRICATED PRODUCTS Larry Wolfe Larry Wolfenbarger Product Sales Engineer

Kentube
FABRICATED PRODUCTS

QUOTATION

TO	EMC Engineers	/318-10351-0-0	PAGE 2 OF 2

ITEM	QUANTITY	DESCRIPTION	UNIT AMOUNT	AMOUNT
		SUGGESTED ACCESSORIES (Quantities below are for each unit)		
	1	Bolted access manway in casing, approximately 16" Square, carbon steel construction.	$ 300	$ 300.
	1	1/2" Threaded connection for safety relief valve on header.	$ 100	$ 100.
	1	1/2" Threaded safety relief valve, Kunkle series 927.	$ 555	$ 555.
	**	All prepaid and bill shipments will be at the billable freight amount plus a service charge of 10%. A service charge is not required for collect shipments or third party billing.		
		* KENTUBE is a member of the * * AMERICAN BOILER MANUFACTURERS ASSOCIATION *		

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 11-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

STACK ECONOMIZER ECO	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
BLDG. 5900 TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
STACK ECONOMIZER & ACC.	6	EA	366.7	2200.0	24	52800			5869.00	35214.00	$88,014	1768	10608
SUBTOTAL						$52,800				$35,214	$88,014		
OVERHEAD, BOND	16%					$8,448				$5,634	$14,082		
PROFIT	10%					$5,280				$3,521	$8,801		
COST SUB-TOTAL						$66,528				$44,370	$110,898		
CONTINGENCY	20%					$13,306				$8,874	$22,180		
SUBTOTAL						$79,834				$53,244	$133,077		
S&A	5.5%					$4,391				$2,928	$7,319		
TOTAL THIS SHEET						$84,224				$56,172	$140,396		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5900EC11
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ECONOMIZER AIR PREHEAT
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	133077.
B. SIOH	$	7320.
C. DESIGN COST	$	7985.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	133544.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	133544.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	6389.	$ 18656.	17.52	326851.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		6389.	$ 18656.		$ 326851.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 107861.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 18656.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 326851.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 2.45
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 7.16

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 5900
ENERGY CONSERVATION OPPORTUNITY: ECO-13
SYSTEM MODIFICATION: VARIABLE SPEED PUMPING
SYSTEMS TO MODIFY: CENTRAL PLANT

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs and spread sheet are compared to determine the energy savings for ECO-13, install variable speed pumping.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	2,224,000	--	7,591
ECO	--	2,021,000	--	6,898
Savings (Baseline-ECO)	0	203,000	0	693

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	692.839 MMBtu/Yr	X	$4.0141 /MMBtu	=	$2,781 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$2,781**	+	**$0**	=	**$2,781 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year
= (+) $0 per year

Maintenance: = (-) $2,507 per year

Total: **$0** - **$2,507** = **($2,507) per year**

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 BASELINE

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	172256.
PEAK DAY GAS CONSUMP., 1000 CU FT	1663.
ELECTRICAL CONSUMPTION, KWH	2224028.
PEAK KW DEMAND (15 MIN BASIS)	1886.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	2224028.
ON-PEAK KW DEMAND (15 MIN BASIS)	1886.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	84
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3443
BOILER 4	2445
BOILER 5	1720
BOILER 6	910
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Total additional annual energy use due to operating chillers 3, 4, and 5 more than necessary: 519,104 kWh/yr
Total electrical consumption: 2,743,132 kWh/yr

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 5900 ECO C7- VARIABLE SPEED PUMPING

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	172256.
PEAK DAY GAS CONSUMP., 1000 CU FT	1663.
ELECTRICAL CONSUMPTION, KWH	1970638.
PEAK KW DEMAND (15 MIN BASIS)	1694.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	1970638.
ON-PEAK KW DEMAND (15 MIN BASIS)	1694.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	2215
CHILLER 3	810
CHILLER 4	419
CHILLER 5	84
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	3624
BOILER 3	3443
BOILER 4	2445
BOILER 5	1720
BOILER 6	910
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

Total electrical consumption =	PC-CUBE est.	1,970,638 kWh
	Spead sheet est.	50,616 kWh
	Total	2,021,254 kWh

VARIABLE PUMPING ESTIMATE

PERCENT LOAD	GPM @ PERCENT LOAD	PART LOAD HRS	PRESSURE FT.HD.	BHP	HP	kW	kWh
10	369	496	1.6	0.19	0.21	0.15	77
20	738	961	6.4	1.49	1.66	1.24	1188
30	1107	1184	14.4	5.03	5.59	4.17	4938
40	1476	221	25.6	11.93	13.25	9.89	2185
50	1845	116	40	23.30	25.88	19.31	2240
60	2214	275	57.6	40.25	44.73	33.37	9176
70	2583	298	78.4	63.92	71.03	52.98	15789
80	2952	37	102.4	95.42	106.02	79.09	2926
90	3321	21	129.6	135.86	150.95	112.61	2365
100	3690	63	160	186.36	207.07	154.47	9732
		3672					50616

1. MAXIMUM (100%) GPM FIXED AT CURRENT FLOW RATE, 3690 GPM
2. PART LOAD HRS FROM CHILLER BASE LOAD RUN FOR INSTRUMENTATION ECO
3. MAXIMUM PRESSURE FT.HD FOR PUMPING, ESTIMATE 160 FT.HD.
   NEW PRESSURE = OLD PRESSURE TIME THE RATIO OF THE SQUARE OF THE FLOWS
4. BHP EQUAL TO GPM TIME HEAD DIVID BY 3960 AND 80% EFFICIENCY
5. HP EQUAL TO BHP DIVIDED BY 90% EFFICIENCY
6. kW EQUAL TO HP TIMES .746 kW per HP
7. kWh EQUAL TO kW TIMES HOURS

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 11-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

DRAWING NO.

SHT OF

ESTIMATOR DJ

CHECKED BY CEL

CHILLER ECO-4 BLDG. 5900	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
VARIABLE SPEED PUMPING TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
PUMP – 900 GPM @ 30 TDH	5	EA	15.0	75.0	22.99	1724	2370	11850			$13,574		
PUMP – 1260 GPM @ 160 TDH	3	EA	17	51.0	22.99	1172	6850	20550			$21,722		
PIPE – 8"	20	FT	1.0	19.2	22.99	441			37.66	753.20	$1,195		
PIPE – 6"	40	FT	0.8	32.0	22.99	736			25.09	1003.60	$1,739		
ELL – 8"	4	EA	6.0	24.0	22.99	552			77.00	308.00	$860		
ELL – 6"	20	EA	4.8	96.0	22.99	2207			41.00	820.00	$3,027		
TEE – 8"	4	EA	9.6	38.4	22.99	883			105.00	420.00	$1,303		
TEE – 6"	2	EA	8	16.0	22.99	368			57.00	114.00	$482		
PIPE INSULATION – 8"*1.5", FG/ASJ	20	FT	0.178	3.6	22.99	82			5.04	100.80	$183		
PIPE INSULATION – 6"*1.5", FG/ASJ	40	FT	0.1	5.8	22.99	133			4.02	160.80	$294		
MOTOR CONTROL CENTER													
10 HP FUNR (1X)	5	EA	2.0	10.0	19.60	196	956	4780			$4,976		
100 HP FUNR (3X)	2	EA	2.6	5.2	19.60	102	3235	6470			$6,572		
100 HP VARIABLE SPEED DRIVE (3X)	1	EA	4.1	4.1	19.60	80	15643	15643			$15,723		
600 AMP CIRCUIT BREAKER (5X)	1	EA	3.6	3.6	19.60	71	2705	2705			$2,776		
INCOMING LINE SECTION	1	EA	10.0	10.0	19.60	196	1030	1030			$1,226		
10 HP MOTOR CIRCUIT WIRING	5	100 FT	12.3	61.5	19.60	1205	262	1310			$2,515		
100 HP MOTOR CIRCUIT WIRING	3	100 FT	27.0	81.0	19.60	1588	1141	3423			$5,011		
FEEDER 4#350, 3" CONDUIT	1	100 FT	25.6	25.6	19.60	502	2313	2313			$2,815		
CONTROL WIRING 9#12	4	100 FT	9.6	38.4	19.60	753	295	1180			$1,933		
CONTROLS	1	EA	110.0	110.0	19.60	2156	4872	4872			$7,028		
CHWP ST/SP	3	EA	2.0	6.0	19.60	117			226.00	678.00	$795		
DP (LIQUID) PUMP STATUS	3	EA	7.9	23.7	19.60	465			205.00	615.00	$1,080		
INSERT. FLOW METER	1	EA	10.1	10.1	19.60	197			764.00	764.00	$961		
AI FORM EMCS	5	EA	4.6	23.0	19.60	451			158.00	790.00	$1,241		
SUBTOTAL						$16,377		$76,126		$6,527	$99,030		
OVERHEAD, BOND	16%					$2,620		$12,180		$1,044	$15,845		
PROFIT	10%					$1,638		$7,613		$653	$9,903		
COST SUB-TOTAL						$20,634		$95,919		$8,225	$124,778		
CONTINGENCY	20%					$4,127		$19,184		$1,645	$24,956		
SUBTOTAL						$24,761		$115,103		$9,869	$149,733		
S&A	5.5%					$1,362		$6,331		$543	$8,235		
TOTAL THIS SHEET						$26,123		$121,433		$10,412	$157,969		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 5900EC13
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: VARIABLE SPEED PUMPING
ANALYSIS DATE: 04-15-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	149733.
B. SIOH	$	8236.
C. DESIGN COST	$	8984.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	150258.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	150258.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	693.	$ 2782.	11.37	31628.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		693.	$ 2782.		$ 31628.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -2507.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -29207.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -29207.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 10437.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 275.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2421.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .02
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 546.98

CENTRAL PLANT 6003

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 6003
ENERGY CONSERVATION OPPORTUNITY: ECO-1
SYSTEM MODIFICATION: ADD INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY: CHILLER PLANT

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-1, install instrumentation to facilitate efficient operation of chiller plant.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	977,000	71,623	74,958
ECO	--	762,000	71,623	74,224
Savings (Baseline-ECO)	0	215,000	0	734

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	734 MMBtu/Yr	X	$4.0141 /MMBtu	=	$2,946 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$2,946**	**+**	**$0**	**=**	**$2,946 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $320 per year

Total: $0 - $320 = ($320)per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	71623.
PEAK DAY GAS CONSUMP., 1000 CU FT	703.
ELECTRICAL CONSUMPTION, KWH	976518.
PEAK KW DEMAND (15 MIN BASIS)	417.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	976518.
ON-PEAK KW DEMAND (15 MIN BASIS)	417.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2615
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

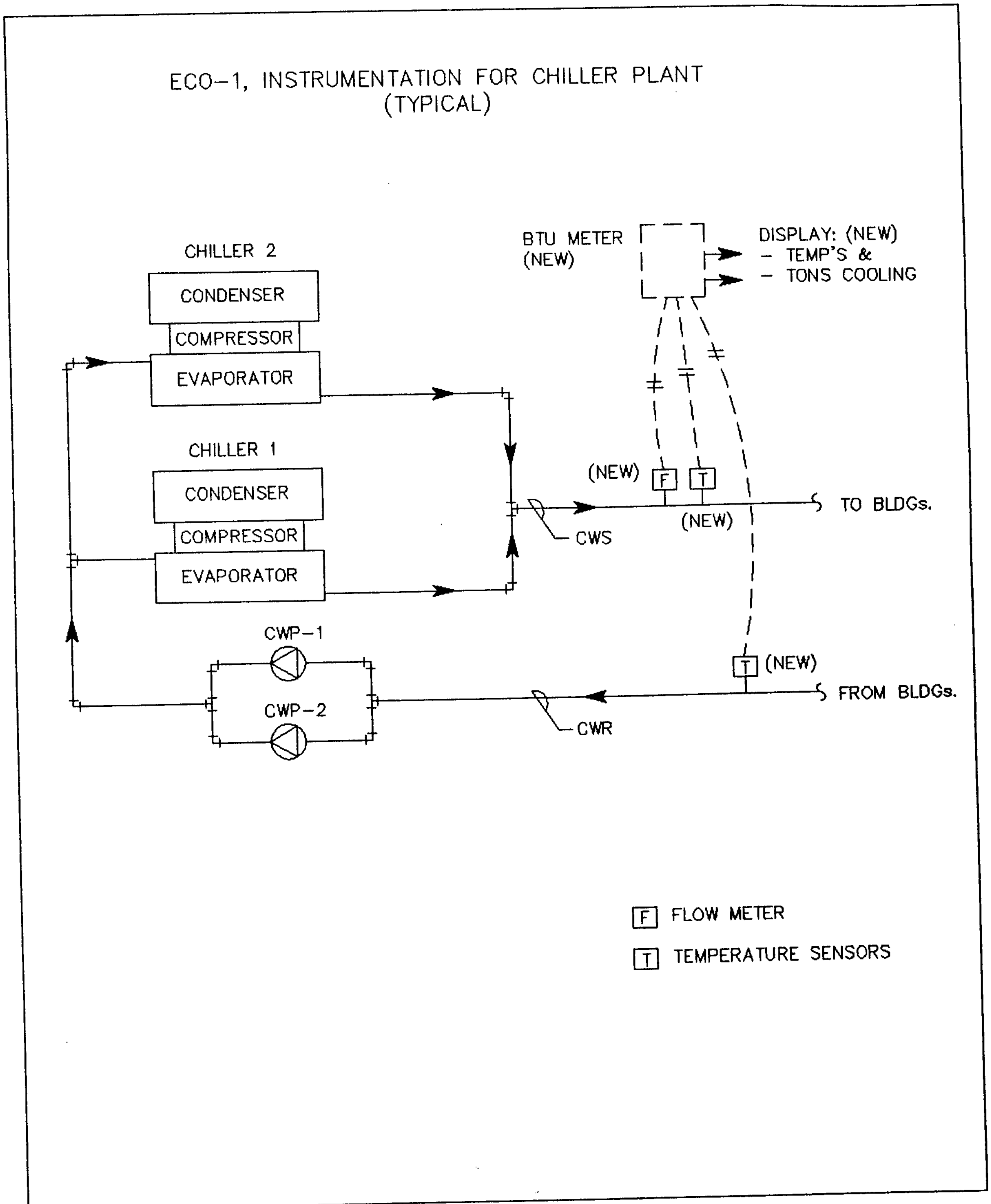
PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 CHILLER ECO-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	71623.
PEAK DAY GAS CONSUMP., 1000 CU FT	703.
ELECTRICAL CONSUMPTION, KWH	761852.
PEAK KW DEMAND (15 MIN BASIS)	445.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	761852.
ON-PEAK KW DEMAND (15 MIN BASIS)	445.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	288
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2615
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.


ECO-1, INSTRUMENTATION FOR CHILLER PLANT
(TYPICAL)
CHILLER 2
CONDENSER
COMPRESSOR
EVAPORATOR
CHILLER 1
CONDENSER
COMPRESSOR
EVAPORATOR
BTU METER
(NEW)
DISPLAY: (NEW)
- TEMP'S &
- TONS COOLING
(NEW)
F
T
(NEW)
TO BLDGs.
CWS
CWP-1
CWP-2
T
(NEW)
FROM BLDGs.
CWR
F FLOW METER
T TEMPERATURE SENSORS

[C-ECO-1.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO-1 BLDG. 6003

INSTRUMENTATION

TASK DESCRIPTION	Quantity No. Of Units	Quantity Unit Meas	LABOR MH/ Unit	LABOR Total Hrs	LABOR Unit Price	LABOR Cost	EQUIPMENT Unit Price	EQUIPMENT Cost	MATERIAL Unit Price	MATERIAL Cost	TOTAL	SHIPPING Unit Wt	SHIPPING Total Wt
INSTRUMENTATION FOR 2 CHILLERS													
CHWS TEMPERATURE SENSOR	1	EA			$176	$176			$328	$328	$504		
CHWR TEMPERATURE SENSOR	1	EA			$176	$176			$328	$328	$504		
INSERT. FLOW METER	1	EA			$197	$197			$764	$764	$961		
BTU METER	1	EA	6.0	6.0	$20	$118			$820	$820	$938		
LED DISPLAY	2	EA							$60	$120	$120		
LED INSTALLATION	2	EA	4.6	9.2	$20	$180			$158	$316	$496		
SUBTOTAL						$847				$2,676	$3,523		
OVERHEAD, BOND	16%					$136				$428	$564		
PROFIT	10%					$85				$268	$352		
COST SUB-TOTAL						$1,067				$3,372	$4,439		
CONTINGENCY	20%					$213				$674	$888		
SUBTOTAL						$1,281				$4,046	$5,327		
S&A	5.5%					$70				$223	$293		
TOTAL THIS SHEET						$1,351				$4,269	$5,620		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: C6003ECO
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: CHILLER INSTRUMENTATION
ANALYSIS DATE: 04-08-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	5327.
B. SIOH	$	293.
C. DESIGN COST	$	320.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	5346.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	5346.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	734.	$ 2946.	8.78	25868.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	0.	$ 0.	12.48	0.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		734.	$ 2946.		$ 25868.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 280.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 2551.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 2551.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 8537.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 3226.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 28419.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 5.32
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 1.66

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 6003
ENERGY CONSERVATION OPPORTUNITY: ECO- 4
SYSTEM MODIFICATION: INSTALL ICE STORAGE COOLING SYSTEM
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Hand calculation sheet was prepared to determine the energy savings for ECO-4, install ice storage system for HVAC cooling.
It was estimated that the peak electrical demand can be saved by installing ice storage cooling system.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	544	0	0	0

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$0**	+	**$0**	=	**$0 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 544 kW/month X $1.787 /kW X 12 months/year

= (+) $11,666 per year

Maintenance: = (-) $0 per year

Total: **$11,666** - **$0** = **$11,666 per year**

[ECO-SHT.WK3]

A new application of an old idea that can cut air conditioning energy costs in half.

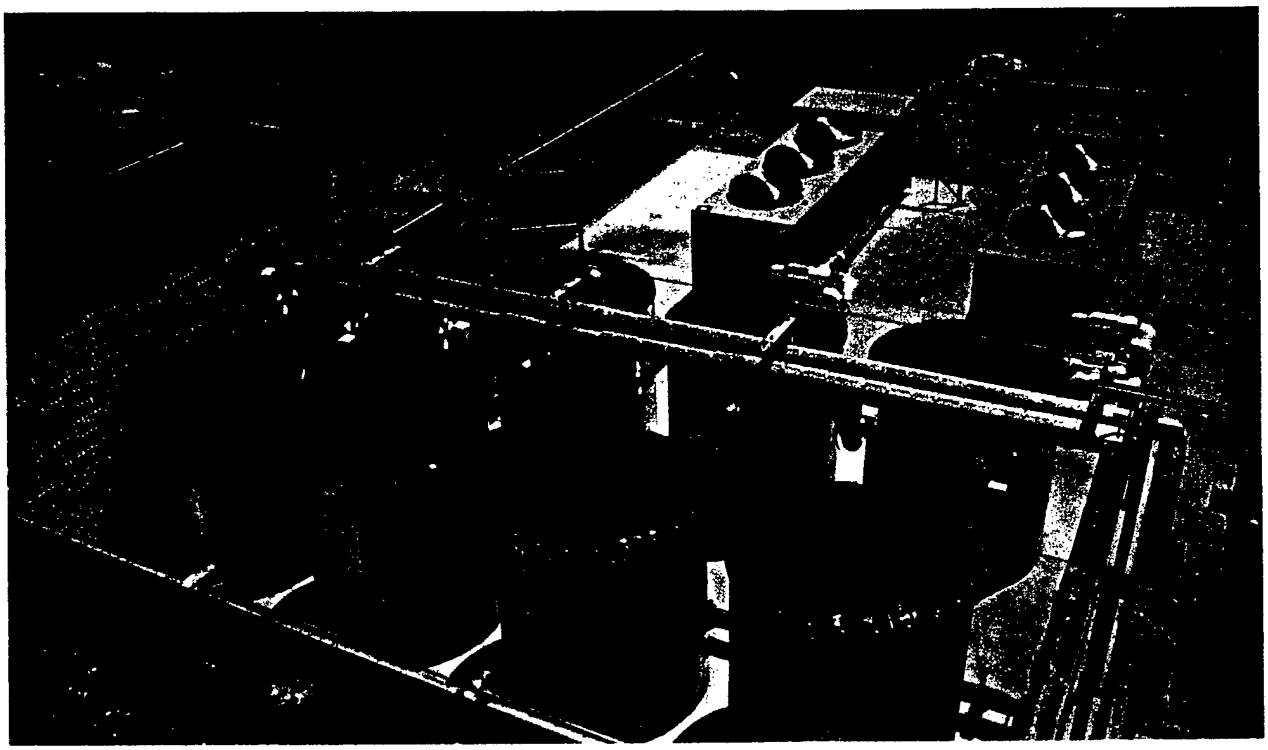
Air conditioning during summer daytime hours is the largest single contributor to utility "peak demand" charges. After noon, as more air conditioners are needed to maintain comfortable temperatures, the increased demand for electricity adds to that already created by lighting, operating equipment, computers and thousands of other uses. This requires the utility to bring additional, more costly generating sources on line to handle its increased demand. Commercial users whose large air conditioning loads contribute to these added generating requirements are assessed an additional charge based on their highest on-peak demand for electricity.

An Ice Bank Stored Cooling System is either a load-shifting or load-leveling method which will significantly lower demand charges during the air conditioning season and, consequently, energy costs. It uses a standard packaged chiller to produce solid ice at night during off-peak periods when the building's electrical needs are at a minimum. The ice is built and stored in modular ice tanks to provide cooling to help meet the building's air conditioning load requirement the following day.

Making ice at night and using its stored energy during the day is not a new or experimental idea. This concept had been employed for years in cooling short-peak applications such as churches and theatres. However, longer peak uses were served by air-source rooftop and chiller-type air conditioners which were less costly to install. Now there is renewed interest in a broad use of ice-making systems by both users and utilities as the best way to offset rising operating costs. In fact, Stored Cooling Systems are what summer-peaking utilities *must have* to avoid the unbearable costs of new generating plants.

Ice Banks not only can cut operating costs in half but they can also substantially reduce capital outlays when systems are suitably designed for new commercial and industrial buildings. Engineers can specify half-size chillers operating 24 hours a day rather than full-size chillers operating only 10 or 12 hours per day. In retrofit applications, an Ice Bank Stored Cooling System can often provide cooling for an addition to a building without adding chiller capacity.

Atlantic Southern Properties Mays Landing NJ



How the LEVLOAD System Works

The LEVLOAD Ice Bank is a modular, insulated polyethylene tank containing a spiral-wound plastic tube heat exchanger surrounded with water. They are available in four sizes – 90, 100, 190 and 570 ton-hours. At night, a 75 percent water - 25 percent glycol solution from a standard packaged air conditioning chiller circulates through the heat exchanger and extracts heat until eventually all the water in the tank is frozen solid. The ice is built uniformly throughout the tank by the patented temperature-averaging effect of closely spaced counterflow heat exchanger tubes, Figure 5. Water does not become surrounded by ice during the freezing process and can move freely as ice forms, preventing stress or damage to the tank.

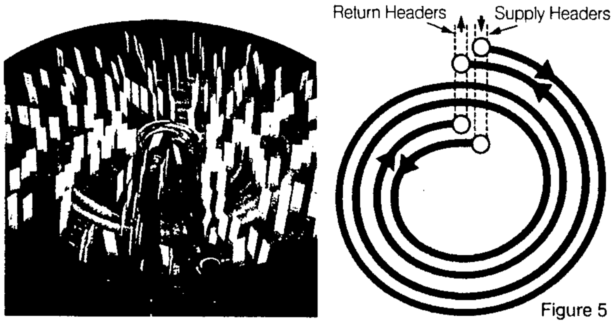


Figure 5

Typical flow diagrams for a Partial Storage System are shown in Figures 6 and 7.

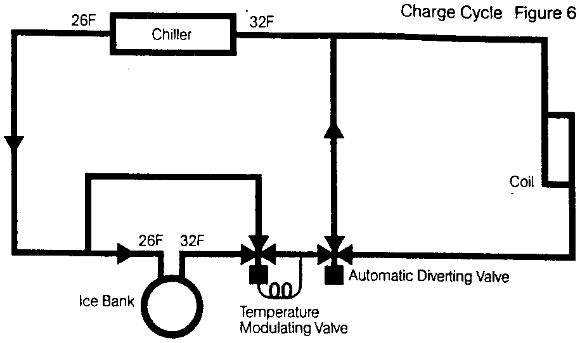
At night, the water-glycol solution circulates through the chiller and the Ice Bank heat exchanger, bypassing the air handler coil. The fluid is at 26F and freezes the water surrounding the heat exchanger.

During the day, the solution is cooled by the Ice Bank from 52F to 34F. A temperature modulating valve set at 44F in a bypass loop around the Ice Bank permits a sufficient quantity of 52F fluid to bypass the Ice Bank, mix with the 34F fluid, and achieve the desired 44F temperature. The 44F fluid enters the coil, where it cools air from 75F to 55F. The fluid leaves the coil at 60F, enters the chiller and is cooled to 52F.

It should be noted that, while making ice at night, the chiller must cool the water-glycol solution to 26F, rather than produce 44 or 45F water temperatures required for conventional air conditioning systems. This has the effect of "derating" the nominal chiller capacity by approximately 30 percent. Compressor efficiency, however, is only slightly reduced because lower nighttime temperatures result in cooler condenser water from the cooling tower and help keep the unit operating efficiently. Similarly, air cooled chillers benefit from cooler condenser entering air temperatures at night.

The temperature modulating valve in the bypass loop has the added advantage of providing unlimited capacity control. During many mild temperature days in the spring and fall, the chiller will be capable of providing all the necessary cooling for the building without assistance from stored cooling. When the building's actual cooling load is equal to or lower than the chiller capacity, all of the system coolant flows through the bypass loop, as in Figure 8.

Charge Cycle Figure 6



Discharge Cycle Figure 7

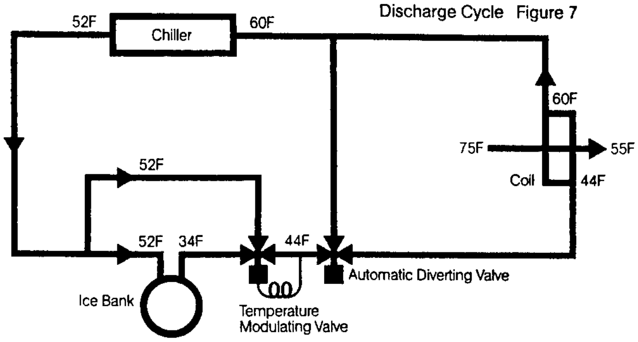
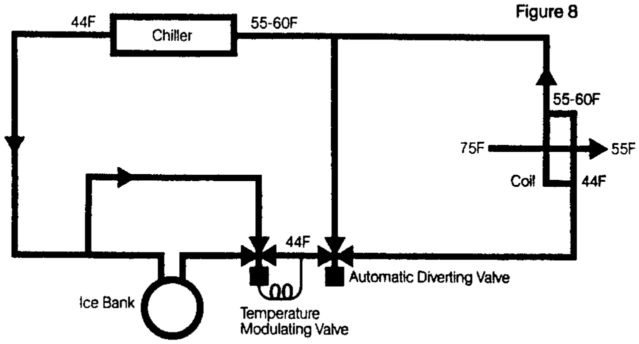


Figure 8



The glycol recommended for the solution is an ethylene glycol-based industrial coolant, such as Dow Chemical Company's Dowtherm® SR-1 or Union Carbide Corporation's UCARTHERM® which are specially formulated for low viscosity and superior heat transfer properties. These contain a multi-component corrosion inhibitor system which is effective with most materials of construction, including aluminum, copper, solder and plastics. Unlike automotive-type anti-freeze, they produce no films and contain no anti-leak agents to interfere with heat transfer efficiency and permit use of standard system pumps, seals and air handler coils. However, because of the slight difference in heat transfer coefficient between water-glycol and plain water, coil capacity should be increased by approximately 5 percent. It is also important that the water and glycol be thoroughly mixed before the solution enters the system.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 6003EC4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: ICE STORAGE COOLING SYSTEM
ANALYSIS DATE: 04-18-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	204000.
B. SIOH	$	11220.
C. DESIGN COST	$	12240.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	204714.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	204714.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	11.37	0.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 11666.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 135909.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 135909.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 0.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 11666.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 135909.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .66
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 17.55

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 6003
ENERGY CONSERVATION OPPORTUNITY: ECO– 5(A)
SYSTEM MODIFICATION: TWO SPEED FANS FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER (NORTH)

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO–5, install two–speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	––	39,462	––	135
ECO	––	13,644	––	47
Savings (Baseline–ECO)	0	25,818	0	88

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 88 MMBtu/Yr X $4.0141 /MMBtu = $354 per year

Nat. Gas: 0 MMBtu/Yr X $2.92 /MMBtu = $0 per year

Total Energy Cost Savings: $354 + $0 = $354 per year

NON–ENERGY SAVINGS (+), COST (–):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (–) $0 per year

Total: $0 – $0 = $0 per year

[ECO–SHT.WK3]

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 6003
ENERGY CONSERVATION OPPORTUNITY: ECO– 5(A)
SYSTEM MODIFICATION: TWO SPEED FANS FOR COOLING TOWER
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CALCULATION DESCRIPTION:
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ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	––	39,462	––	135
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Savings (Baseline–ECO)	0	25,818	0	88

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	88 MMBtu/Yr	X	$4.0141 /MMBtu	=	$354 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$354**	+	**$0**	=	**$354 per year**

NON–ENERGY SAVINGS (+), COST (–):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (–) $0 per year

Total: $0 – $0 = $0 per year

[ECO–SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input. The calculations take into account multi-cell towers (part 7). The control sequence is:

- 0-25% load, fan 1, half speed cycling.
- 25-50% load, fan 1 half speed running, fan 2 half speed cycling:
- 50-75% load, fan 1 full speed cycling, fan 2 half speed running.
- 75-100% load, fan 1 full speed running, fan 2 full speed cycling.

kWh per bin, for % design loads less than 25% load = (fan 1 power kW) * 14% * (%design load / 25) * 4 hours per bin * days per month.

kWh per bin, for % design loads 25% to 50% load = (fan 1 power kW * 14% * 4 hours per bin * days per month) * (fan 2 power kW * 14% * ((% design load - 25)/ 25)* 4 hours per bin * days per month)

kWh per bin, for % design loads 50% to 75% load = (fan 2 power kW * 14% * 4 hours per bin * days per month) * (fan 1 power kW * ((% design load - 50)/ 25) * 4 hours per bin * days per month)

kWh per bin, for % design loads 75% to 100% load = (fan 1 power kW * 4 hours per bin * days per month) + (fan 2 power kW * ((% design load - 75)/ 25) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 6003	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	78
– WATER FLOW (gpm)	2260
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	9379
HEAT REJECTION CAPACITY (Btu/min)	187580
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	41.58
TOTAL ENTHALPY	61.58
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	141623
MOTOR DATA	
– FAN 1 POWER (kW)	36.3
– FAN 2 POWER (kW)	0
– FAN 3 POWER (kW)	0
– FAN 4 POWER (kW)	0

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET–BULB AVERAGES (4 hour bins)						DESIGN
	1–4	5–8	9–12	13–16	17–20	21–24	WB
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	78
MAY	57.1	56.6	61.2	63.9	63	59.4	78
JUNE	66.8	66.6	69.9	71	70.5	68.2	78
JULY	70.8	70.9	74.5	76	74.9	72.6	78
AUGUST	66.9	67	71	72	71	68.5	78
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	78
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	78

ENTHALPY FOR AVERAGE WET-BULBS							DESIGN
	1-4	5-8	9-12	13-16	17-20	21-24	ENTHALPY
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	41.58
MAY	24.53	24.21	27.28	29.23	28.57	26.06	41.58
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	41.58
JULY	34.77	34.86	38.14	39.57	38.52	36.37	41.58
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	41.58
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	41.58
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	41.58

COOLING PROFILE OF CENTRAL PLANTS							PEAK LOAD
	1-4	5-8	9-12	13-16	17-20	21-24	(Btuh)
APRIL	0	0	0	0	0	0	0
MAY	0.3	0.3	0.7	0.7	0.3	0.3	7151000
JUNE	0.3	0.3	0.7	0.7	0.3	0.3	9058000
JULY	0.3	0.3	0.7	0.7	0.3	0.3	9058000
AUGUST	0.3	0.3	0.7	0.7	0.3	0.3	9058000
SEPTEMBER	0.3	0.3	0.7	0.7	0.3	0.3	9058000
OCTOBER	0	0	0	0	0	0	0

RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY							DAYS PER
	1-4	5-8	9-12	13-16	17-20	21-24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	1.9	1.9	1.7	1.6	1.7	1.8	31
JUNE	1.5	1.5	1.4	1.3	1.4	1.4	30
JULY	1.3	1.3	1.2	1.1	1.2	1.3	31
AUGUST	1.5	1.5	1.3	1.3	1.3	1.4	31
SEPTEMBER	1.6	1.6	1.5	1.4	1.5	1.6	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

% DESIGN LOAD							DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	12.8	12.7	32.2	34.2	14.3	13.3	31
JUNE	19.9	19.8	50.8	52.6	22.2	20.7	30
JULY	22.4	22.5	59.7	63.6	26.0	23.8	31
AUGUST	20.0	20.0	52.6	54.4	22.5	20.9	31
SEPTEMBER	19.1	19.0	47.7	49.1	20.2	19.3	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

SINGLE SPEED CONTROL (kWh)							TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kW)
APRIL	0	0	0	0	0	0	
MAY	575	571	1450	1538	646	600	
JUNE	868	863	2212	2290	965	902	
JULY	1007	1011	2688	2863	1171	1071	
AUGUST	899	901	2366	2447	1014	940	
SEPTEMBER	831	827	2079	2141	881	841	
OCTOBER	0	0	0	0	0	0	
TOTAL	4181	4173	10796	11279	4678	4354	39462

TWO SPEED CONTROL (kWh)							TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	161	160	406	431	181	168	
JUNE	243	242	678	834	270	252	
JULY	282	283	1506	1855	328	300	
AUGUST	252	252	862	1023	284	263	
SEPTEMBER	233	232	582	599	247	236	
OCTOBER	0	0	0	0	0	0	
TOTAL	1171	1169	4034	4743	1310	1219	13644

COST ESTIMATE ANALYSIS

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER ______

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

CHILLER ECO BLDG. 6003 / 2-SPEED COOLING TOWER	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
50 HP 2-SPD MOTOR	1	EA	5.0	5.0	20	98			5503.00	5503.00	$5,601		
2-SPD MOTOR STARTER	1	EA	4.2	4.2	20	82			859.00	859.00	$941		
MOTOR FEEDER	1	LS	4.1	4.1	20	80			20.00	20.00	$100		
REMOVE OLD MOTOR	1	EA	3.3	3.3	20	65					$65		
REMOVE OLD STR	1	EA	4.2	4.2	20	82					$82		
PNEUMATIC THERMOSTAT	2	EA	1.0	2.0	20	39			34.12	68.24	$107		
SUBTOTAL						$447				$6,450	$6,897		
OVERHEAD, BOND	16%					$72				$1,032	$1,104		
PROFIT	10%					$45				$645	$690		
COST SUB-TOTAL						$563				$8,127	$8,690		
CONTINGENCY	20%					$113				$1,625	$1,738		
SUBTOTAL						$676				$9,753	$10,428		
S&A	5.5%					$37				$536	$574		
TOTA[illegible]IS SHEET						$713				$10,289	$11,002		

DA FOR[illegible]-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 6003EC5A
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	10428.
B. SIOH	$	574.
C. DESIGN COST	$	626.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	10465.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	10465.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	88.	$ 354.	11.37	4022.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		88.	$ 354.		$ 4022.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1327.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 354.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 4022.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .38
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 29.59

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 6003
ENERGY CONSERVATION OPPORTUNITY: ECO– 5(B)
SYSTEM MODIFICATION: VARIABLE SPEED DRIVE FOR COOLING TOWER
SYSTEMS TO MODIFY: COOLING TOWER (NORTH)

CALCULATION DESCRIPTION:
Two spread sheets are compared to determine the energy savings for ECO–5, install two–speed (5A) or variable speed (5B) motors for cooling tower. The spread sheets is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The spread sheets is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the spread sheets represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	––	39,462	––	135
ECO	––	8,437	––	29
Savings (Baseline–ECO)	0	31,025	0	106

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	106 MMBtu/Yr	X	$4.0141 /MMBtu	=	$425 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$425**	**+**	**$0**	**=**	**$425 per year**

NON–ENERGY SAVINGS (+), COST (–):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (–) $570 per year

Total: $0 – $570 = ($570) per year

[ECO–SHT.WK3]

Two-speed cooling tower and variable speed cooling tower calculation description:

1. The design conditions were taken from the original design documents, including wet bulb temperatures, condenser water flow, and condenser supply and return temperatures.

2. Based on an assumed liquid to gas ratio, the delta enthalpy was calculated for entering air versus leaving air conditions. The final total enthalpy of the leaving air was calculated based on the design entering air enthalpy plus the delta enthalpy.

3. The fan motor kW is based on field measurements.

4. The "WET BULB AVERAGEs" are the wet bulb temperatures calculated for 4 hour bins, for each cooling month, from ASHRAE weather data for Oklahoma City, Oklahoma (part 1).

5. The "ENTHALPY FOR AVERAGE WET BULBS" are the enthalpy for each of the wet-bulb (part 1.), determined from look-up tables (part 2).

6. The "COOLING PROFILE OF CENTRAL PLANTS," is the average % load estimated for the chiller plant, for the time bins (part 3). Note there is 0% load for those hours when the chiller is assumed to be off.

   The "PEAK LOAD" per month is the estimated peak hourly load (part 3, last column).

7. The "RATIO OF AVERAGE MONTHLY ENTHALPY TO DESIGN ENTHALPY" for time bins (part 4) =

   (Total exit air design enthalpy minus average monthly enthalpy, part 2) / (entering air design enthalpy)

   The "DAYS PER MONTH OPER." is the total days per month the cooling tower operates (part 4, last columm).

8. The "% DESIGN LOAD" on tower for time bins (part 5) =

   (% load on plant, part 3 * monthly peak load, part 3) / (Highest monthly peak load, part 3) * (1 / ratio of monthly enthalpy, part 4)

9. For a single speed cooling tower fan the energy usage (kWh) is based on the idea that the tower fan cycle in direct proportion to the % design load on the tower, (part 6) =

   kWh per bin = (total fan power kW) * (% design load, part 5 * 4 hours per bin * days per month)

   Total kWh = sum of all kWh bins

10. For a two-speed cooling tower fan the energy usage (kWh) is based on the premise that when a tower cell is at less than 50% of its design load, it operates at half speed. A fan running at half speed uses 14% of the maximum power input. The calculations take into account multi-cell towers (part 7). The control sequence is:

- 0-25% load, fan 1, half speed cycling.
- 25-50% load, fan 1 half speed running, fan 2 half speed cycling:
- 50-75% load, fan 1 full speed cycling, fan 2 half speed running.
- 75-100% load, fan 1 full speed running, fan 2 full speed cycling.

kWh per bin, for % design loads less than 25% load = (fan 1 power kW) * 14% * (%design load / 25) * 4 hours per bin * days per month.

kWh per bin, for % design loads 25% to 50% load = (fan 1 power kW * 14% * 4 hours per bin * days per month) * (fan 2 power kW * 14% * ((% design load - 25)/ 25)* 4 hours per bin * days per month)

kWh per bin, for % design loads 50% to 75% load = (fan 2 power kW * 14% * 4 hours per bin * days per month) * (fan 1 power kW * ((% design load - 50)/ 25) * 4 hours per bin * days per month)

kWh per bin, for % design loads 75% to 100% load = (fan 1 power kW * 4 hours per bin * days per month) + (fan 2 power kW * ((% design load - 75)/ 25) * 4 hours per bin * days per month)

kWh total = sum of all kWh bins

11. For a variable speed cooling tower fan the energy usage (kWh) is based on the premise that the tower fan percent air volume is directly proportional to the percent load on the cooling tower; and the fan energy is proportational to the cube of the air volume. The calculations take into account multi-cell towers (part 8):

kWh per bin, for 0 to 100% load = (total fan power kW) * ((% design load)^3 / 80% efficiency) * 4 hours per bin * days per month.

kWh total = sum of all kWh bins

CENTRAL PLANT 6003	
DESIGN CONDITIONS	
– WBT (DB, DEG F)	78
– WATER FLOW (gpm)	2260
– CNWR (DEG F)	95
– CNWS (DEG F)	85
ASSUMPTION LIQUID TO GAS RATIO	2
– AIR FLOW (LBS/MIN)	9379
HEAT REJECTION CAPACITY (Btu/min)	187580
DELTA ENTHALPY (Btu/lb)	20
DESIGN ENTHALPY (Btu/lb)	41.58
TOTAL ENTHALPY	61.58
EXIT AIR WB (LOOK UP)	93.2
SPECIFIC VOLUME OF EXIT AIR (LOOK UP)	15.1
100% DESIGN CFM @ WB	141623
MOTOR DATA	
– FAN 1 POWER (kW)	36.3
– FAN 2 POWER (kW)	0
– FAN 3 POWER (kW)	0
– FAN 4 POWER (kW)	0

ASHRAE WEATHER DATA – OKLAHOMA CITY, OKLAHOMA

	WET–BULB AVERAGES (4 hour bins)						DESIGN WB
	1–4	5–8	9–12	13–16	17–20	21–24	
APRIL	48.6	47.8	52.2	55.6	54.6	51.4	78
MAY	57.1	56.6	61.2	63.9	63	59.4	78
JUNE	66.8	66.6	69.9	71	70.5	68.2	78
JULY	70.8	70.9	74.5	76	74.9	72.6	78
AUGUST	66.9	67	71	72	71	68.5	78
SEPTEMBER	65.1	64.9	67.8	68.9	67.4	65.6	78
OCTOBER	51.2	50.4	55.1	57.5	55.2	52.5	78

ENTHALPY FOR AVERAGE WET-BULBS							DESIGN
	1-4	5-8	9-12	13-16	17-20	21-24	ENTHALPY
APRIL	19.64	19.11	21.55	23.58	22.98	21.09	41.58
MAY	24.53	24.21	27.28	29.23	28.57	26.06	41.58
JUNE	31.47	31.31	34.01	34.95	34.51	32.59	41.58
JULY	34.77	34.86	38.14	39.57	38.52	36.37	41.58
AUGUST	31.54	31.62	34.95	35.83	34.95	32.84	41.58
SEPTEMBER	30.13	29.98	32.25	33.09	31.93	30.52	41.58
OCTOBER	20.98	20.53	23.28	24.72	23.34	21.72	41.58

COOLING PROFILE OF CENTRAL PLANTS							PEAK LOAD
	1-4	5-8	9-12	13-16	17-20	21-24	(Btuh)
APRIL	0	0	0	0	0	0	0
MAY	0.3	0.3	0.7	0.7	0.3	0.3	7151000
JUNE	0.3	0.3	0.7	0.7	0.3	0.3	9058000
JULY	0.3	0.3	0.7	0.7	0.3	0.3	9058000
AUGUST	0.3	0.3	0.7	0.7	0.3	0.3	9058000
SEPTEMBER	0.3	0.3	0.7	0.7	0.3	0.3	9058000
OCTOBER	0	0	0	0	0	0	0

RATIO OF MONTHLY ENTHALPY TO DESIGN ENTHALPY							DAYS PER
	1-4	5-8	9-12	13-16	17-20	21-24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	1.9	1.9	1.7	1.6	1.7	1.8	31
JUNE	1.5	1.5	1.4	1.3	1.4	1.4	30
JULY	1.3	1.3	1.2	1.1	1.2	1.3	31
AUGUST	1.5	1.5	1.3	1.3	1.3	1.4	31
SEPTEMBER	1.6	1.6	1.5	1.4	1.5	1.6	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	% DESIGN LOAD						DAYS PER
	1–4	5–8	9–12	13–16	17–20	21–24	MONTH OPER.
APRIL	0.0	0.0	0.0	0.0	0.0	0.0	30
MAY	12.8	12.7	32.2	34.2	14.3	13.3	31
JUNE	19.9	19.8	50.8	52.6	22.2	20.7	30
JULY	22.4	22.5	59.7	63.6	26.0	23.8	31
AUGUST	20.0	20.0	52.6	54.4	22.5	20.9	31
SEPTEMBER	19.1	19.0	47.7	49.1	20.2	19.3	30
OCTOBER	0.0	0.0	0.0	0.0	0.0	0.0	31

	SINGLE SPEED CONTROL (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kW)
APRIL	0	0	0	0	0	0	
MAY	575	571	1450	1538	646	600	
JUNE	868	863	2212	2290	965	902	
JULY	1007	1011	2688	2863	1171	1071	
AUGUST	899	901	2366	2447	1014	940	
SEPTEMBER	831	827	2079	2141	881	841	
OCTOBER	0	0	0	0	0	0	
TOTAL	4181	4173	10796	11279	4678	4354	39462

	TWO SPEED CONTROL (kWh)						TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	161	160	406	431	181	168	
JUNE	243	242	678	834	270	252	
JULY	282	283	1506	1855	328	300	
AUGUST	252	252	862	1023	284	263	
SEPTEMBER	233	232	582	599	247	236	
OCTOBER	0	0	0	0	0	0	
TOTAL	1171	1169	4034	4743	1310	1219	13644

VARIABLE SPEED COOLING TOWER CYCLING (kWh)							TOTAL
	1–4	5–8	9–12	13–16	17–20	21–24	(kWh)
APRIL	0	0	0	0	0	0	
MAY	12	11	188	224	17	13	
JUNE	43	42	713	791	59	48	
JULY	63	64	1199	1448	99	76	
AUGUST	45	45	818	904	64	51	
SEPTEMBER	38	37	592	646	45	39	
OCTOBER	0	0	0	0	0	0	
TOTAL	201	200	3510	4014	285	228	8437

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C

[ ] OTHER ________

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

CHILLER ECO BLDG. 6003	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
VARIABLE SPEED COOLING TOWER TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
VFD FOR ONE 50 HP MOTOR	1	EA	4	4	20	78			5600	5600	$5,678		
VFD WIRING & CONNECTION	1	LS	4.07	4	20	80			20	20	$100		
WATER TEMPERATURE SENSOR	1	EA	8.98	9	20	176			328	328	$504		
SUBTOTAL						$334				$5,948	$6,282		
OVERHEAD, BOND	16%					$53				$952	$1,005		
PROFIT	10%					$33				$595	$628		
COST SUB-TOTAL						$421				$7,494	$7,916		
CONTINGENCY	20%					$84				$1,499	$1,583		
SUBTOTAL						$505				$8,993	$9,499		
S&A	5.5%					$28				$495	$522		
TOTAL THIS SHEET						$533				$9,488	$10,021		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 6003EC5B
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: TWO SPEED COOLING TOWER
ANALYSIS DATE: 04-11-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	9499.
B. SIOH	$	523.
C. DESIGN COST	$	570.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	9533.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	9533.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	106.	$ 425.	11.37	4833.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		106.	$ 425.		$ 4833.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -570.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -6641.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -6641.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1595.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -145.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ -1808.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= -.19
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -65.76

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 6003
ENERGY CONSERVATION OPPORTUNITY: ECO- 6
SYSTEM MODIFICATION: HIGH EFFICIENCY MOTOR REPLACEMENT
SYSTEMS TO MODIFY: PUMP & COOLING TOWER MOTORS

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-6, install high efficiency motors.
It was estimated that the electrical energy can be saved by installing high efficiency motors based on the motor operating hours per year.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	12	25,861	0	88

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	88 MMBtu/Yr	X	$4.0141 /MMBtu	=	$354 per year
Nat. Gas:	0 MMBtu/Yr	X	$2.92 /MMBtu	=	$0 per year
Total Energy Cost Savings:	**$354**	+	**$0**	=	**$354 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 12 kW/month X $1.787 /kW X 12 months/year

= (+) $257 per year

Maintenance: = (-) $0 per year

Total: **$257** - **$0** = **$257 per year**

[ECO-SHT.WK3]

HIGH EFFICIENCY
MOTOR REPLACEMENT

LABOR RATE:	19.6	$/hr
ELECTRIC CONS.	0.0137	$/kWH
ELECTRIC DEMAND	1.787	$/kW

BLDG. NO.	EQUIPMENT SERVE	MOTOR HP	MOTOR FLA	MEAS AMPS	MEAS PF	MEAS VOLT	EXST EFF	NEW EFF	KW SVGS	HRS/ YEAR	KWH/YR SVGS	SVGS/ YEAR
5900	CWP-1	50.0	62.5	60	0.82	460	91.35%	93.00%	0.76	3672	2800	$55
	CWP-2	60.0	69	53.6	0.88	460	92.52%	94.50%	0.85	2215	1884	$44
	CWP-3	60.0	75	62	0.83	460	89.92%	94.50%	2.22	810	1796	$72
	CWP-4	75.0	93	82.3	0.87	460	86.79%	93.60%	4.78	419	2003	$130
	CWP-5	60.0	77	67	0.80	460	91.43%	94.50%	1.51	84	127	$34
	CNWP-1	25.0	32	26.3	0.82	460	89.42%	91.70%	0.48	3672	1746	$34
	CNWP-2	30.0	39.8	35.6	0.78	460	90.25%	92.40%	0.57	2215	1266	$30
	CNWP-3	30.0	38	35.6	0.82	460	89.71%	92.40%	0.76	810	615	$25
	CNWP-4	40.0	52	42.9	0.78	460	92.34%	93.00%	0.21	419	86	$6
	CNWP-5	30.0	38	32	0.83	460	89.06%	92.40%	0.86	84	72	$19
	CTM-1	25.0	31	27.2	0.87	460	86.79%	91.70%	1.16	2229	2592	$60
	CTM-2	NI	NI	NI								
	CTM-3	NI	NI	NI								
	CTM-4	NI	NI	NI								
	CTM-5	20.0	24	24.6	0.87	460	89.69%	91.00%	0.27	84	23	$6
	HWP(ret)-1	2.0	6.2	5.6	0.87	230	69.43%	84.00%	0.48	3624	1757	$34
	HWP(ret)-2	2.0	6.2	5.4	0.87	230	69.43%	84.00%	0.47	3624	1694	$33
	HWP(ret)-3	2.0	6.2	5.5	0.87	230	69.43%	84.00%	0.48	3443	1639	$33
	HWP(ret)-4	2.0	6.2	5.3	0.87	230	69.43%	84.00%	0.46	2445	1122	$25
	HWP(ret)-5	2.0	6.3	5.4	0.87	460	34.17%	84.00%	6.50	1720	11179	$293
	HWP(sup)-6	2.0	6.2	5.5	0.87	230	69.43%	84.00%	0.48	910	433	$16
	HWP(sup)-7	15.0	19.8	16.7	0.87	460	81.53%	90.20%	1.36	3624	4945	$97
	HWP(sup)-8	20.0	24	15.2	0.87	460	89.69%	91.00%	0.17	2174.4	369	$9
	HWP(sup)-9	20.0	25	15.6	0.86	460	87.51%	91.00%	0.47	2174.4	1015	$24
	HWP(sup)-10	15.0	19.8	16.7	0.79	460	89.79%	90.20%	0.05	1449.6	77	$[illegible]
	HWP(sup)-11	25.0	30	29	0.93	460	83.90%	91.70%	2.18	1449.6	3158	$90
		DEMAND CREDIT		**$590**	**MMBtu**	**145**		**TOTAL**	**28**		**42400**	**$1,171**
6003	CWP-1	NI	NI	NI								
	CWP-2	50.0	62.5	44.6	0.81	460	92.48%	93.00%	0.18	3672	645	$13
	CWP-3	50.0	62.5	46.4	0.87	460	86.10%	93.00%	2.77	3672	10181	$199
	CNWP-1	NI	NI	NI								
	CNWP-2	30.0	37	32	0.84	460	90.38%	92.40%	0.52	3672	1905	$37
	CNWP-3	30.0	37	31	0.87	460	87.26%	92.40%	1.37	3672	5029	$98
	CTM-1	50.0	63	56.3	0.87	460	85.41%	93.00%	3.73	1087	4051	$135
	CTM-2	50.0	63	56.3	0.87	460	85.41%	93.00%	3.73	1087	4051	$135
		DEMAND CREDIT		**$264**	**MMBtu**	**88**		**TOTAL**	**12**		**25861**	**$618**

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A [X] CODE B [ ] CODE C [ ] OTHER

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 10-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

MOTOR REP. ECO BLDG. 6003 HIGH EFF. MOTOR REP.LACEMENT	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CWP-2 50.0 HP MOTOR	1	EA	9.0	9.0	20	176			2579.0	2579.00	$2,755		
CWP-3 50.0 HP MOTOR	1	EA	9.0	9.0	20	176			2579.0	2579.00	$2,755		
CNWP-2 30.0 HP MOTOR	1	EA	6.0	6.0	20	117			1639.0	1639.00	$1,756		
CNWP-3 30.0 HP MOTOR	1	EA	6.0	6.0	20	117			1639.0	1639.00	$1,756		
CTM-1 50.0 HP MOTOR	1	EA	9.0	9.0	20	176			2579.0	2579.00	$2,755		
CTM-2 50.0 HP MOTOR	1	EA	9.0	9.0	20	176			2579.0	2579.00	$2,755		
SUBTOTAL						$941				$13,594	$14,535		
OVERHEAD, BOND	16%					$150				$2,175	$2,326		
PROFIT	10%					$94				$1,359	$1,453		
COST SUB-TOTAL						$1,185				$17,128	$18,314		
CONTINGENCY	20%					$237				$3,426	$3,663		
SUBTOTAL						$1,422				$20,554	$21,976		
S&A	5.5%					$78				$1,130	$1,209		
TOTAL THIS SHEET						$1,500				$21,685	$23,185		

DA FORM 5418-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: 6003EC6
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: HIGH EFF. MOTOR
ANALYSIS DATE: 04-10-91 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	21976.
B. SIOH	$	1209.
C. DESIGN COST	$	1319.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	22054.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	22054.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	88.	$ 354.	11.37	4030.
B. DIST	$ .00	0.	$ 0.	17.06	0.
C. RESID	$ .00	0.	$ 0.	16.85	0.
D. NAT G	$ 2.92	0.	$ 0.	17.52	0.
E. COAL	$ .00	0.	$ 0.	13.34	0.
F. TOTAL		88.	$ 354.		$ 4030.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 257.
(1) DISCOUNT FACTOR (TABLE A) 11.65
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 2994.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ 2994.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1330.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= .24
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 611.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 7024.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .32
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 36.07

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 6003
ENERGY CONSERVATION OPPORTUNITY: ECO-7
SYSTEM MODIFICATION: INSTALL INSTRUMENTATION TO DETERMINE LOAD
SYSTEMS TO MODIFY:

CALCULATION DESCRIPTION:
Analysis spread sheet was prepared to determine the energy savings for ECO-7, install instrumentation to facilitate efficient operation of boiler plant. It was estimated that the energy wasted from boiler in standby is 1% of the rated output capacity. The hours when boilers are running unnecessary were estimated for each boiler.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric		Nat. Gas	Total Energy
	Demand(kW)	Energy(kWh)	(MMBtu)	(MMBtu)
Baseline	--	--	--	0
ECO	--	--	--	0
Savings (Baseline-ECO)	0	0	67	67

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity:	0 MMBtu/Yr	X	$4.0141 /MMBtu	=	$0 per year
Nat. Gas:	67 MMBtu/Yr	X	$2.92 /MMBtu	=	$196 per year
Total Energy Cost Savings:	**$0**	**+**	**$196**	**=**	**$196 per year**

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $255 per year

Total: $0 - $255 = ($255) per year

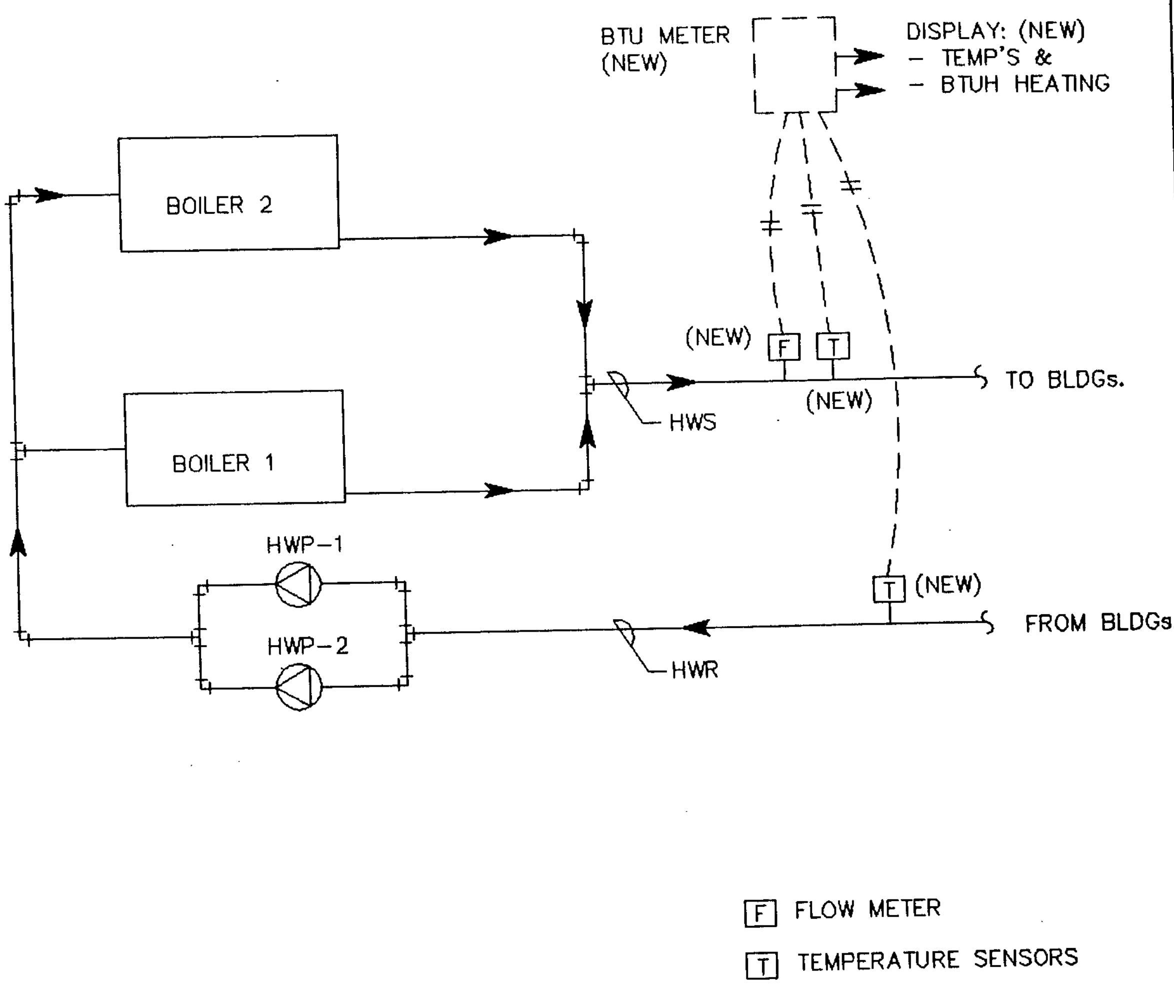
[ECO-SHT.WK3]

BOILER STANDBY SAVINGS

CENTRAL PLANT	BOILER NO.	BOILER TYPE	BOILER MANUFACTURERER	BOILER MODEL NUMBER	RATED BOILER OUTPUT MMBTU/H	CALC. BOILER OUTPUT MMBTU/H	STANDBY LOSS (1%) MMBTU/H	EXCESS STANDBY (HRS/YR)	EXCESS STANDBY MMBTU/H	EXCESS STANDBY SAVINGS ($)
5900	1	HTHW	INTERNATIONAL	D-12	10.00	6.94	0.0694	0		
	2	HTHW	INTERNATIONAL	D-12	10.00	7.17	0.0717	720	51.62	$150.74
	3	HTHW	HERCULES	300	9.70	7.61	0.0761	720	54.82	$160.09
	4	HTHW	HERCULES	300	9.70	7.58	0.0758	720	54.55	$159.27
	5	HTHW	INTERNATIONAL	1035 TH12	8.00	6.22	0.0622	0		
	6	HTHW	INTERNATIONAL	TJW-C-10	11.20	8.88	0.0888	0		
						TOTAL		2160	160.99	$470.10
6003	1	STEAM-12	KEWANEE	L39-350-605	11.72	9.41	0.0941	0		
	2	STEAM-12	YORK SHIPLEY	SPL-350-112080	11.72	9.12	0.0912	0		
	3	STEAM-12	KEWANEE	L36-350-605	11.72	9.37	0.0937	720	67.45	$196.96
						TOTAL		720	67.45	$196.96
730	1	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	0		
	2	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.16	0.0616	720	44.34	$129.47
	3	STEAM-12	KEWANEE	CAT#7L286-KX	7.75	6.18	0.0618	720	44.51	$129.96
	4	STEAM-12	KEWANEE	CAT#7L280-KG-06	2.66	2.11	0.0211	0		
						TOTAL		1440	88.84	$259.43
2812	1	STEAM-12	FEDERAL BOILER CO	GS 3562	1.80	1.40	0.0140	0		
	2	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.77	0.0277	0		
	3	HW	THERMO-PAK BOILER INC.	GW5500X	3.95	2.86	0.0286	720	20.62	$60.21
						TOTAL		720	20.62	$60.21
5676	1	HW	AMERICAN STANDARD	PF 515	2.44	1.80	0.0180	720	12.93	$37.76
	2	HW	AMERICAN STANDARD	PF 515	2.44	1.71	0.0171	0		
						TOTAL		720	12.93	$37.76
5678	1	HW	BRUNHAM	PF 514	2.27	1.50	0.0150	720	10.79	$31.50
	2	HW	BRUNHAM	PF 514	2.27	1.63	0.0163	0		
						TOTAL		720	10.79	$31.50
914	1	STEAM-12	BRUNHAM	PF-510	1.61	1.29	0.0129	0		
	2	HW	RAY-PAK	EA 200ITB	1.61	1.22	0.0122	0		
	3	HW	AMERICAN STANDARD	G1015	1.92	1.47	0.0147	720	10.56	$30.84
	4	HW	AMERICAN STANDARD	G1015	1.92	1.40	0.0140	0		
						TOTAL		720	10.56	$30.84
4701	1	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	0		
	2	STEAM-100	BIRCHFIELD	FBH 578	11.00	0.00	0.0000	0		
	3	STEAM-100	BIRCHFIELD	FBH 578	11.00	8.43	0.0843	720	60.73	$177.33
						TOTAL		720	60.73	$177.33

[BOILERS.WK3]

ECO-7, INSTRUMENTATION FOR BOILER PLANT
(TYPICAL)



[B-ECO-7.DWG]

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.
DACA 59-90-C-0087

[ ] CODE A [X] CODE B [ ] CODE C
[ ] OTHER ________

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 04-Apr-91

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

BOILER ECO BLDG. 6003	Quantity		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
INSTRUMENTATION TASK DESCRIPTION	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
INSTRUMENTATION FOR 3 STM BOILERS													
INSERT. FLOW METER	1	EA			197	197			1800.00	1800.00	$1,997		
STM FLOW PROCESSOR	1	EA	6.0	6.0	20	118			695.00	695.00	$813		
SUBTOTAL						$315				$2,495	$2,810		
OVERHEAD, BOND	16%					$50				$399	$450		
PROFIT	10%					$31				$250	$281		
COST SUB-TOTAL						$396				$3,144	$3,540		
CONTINGENCY	20%					$79				$629	$708		
SUBTOTAL						$476				$3,772	$4,248		
S&A	5.5%					$26				$207	$234		
TOTAL THIS SHEET						$502				$3,980	$4,482		

DA FOR[illegible]-R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: B6003EC1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.035
INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER INSTRUMENTATION
ANALYSIS DATE: 04-12-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	4248.
B. SIOH	$	234.
C. DESIGN COST	$	255.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	4263.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	4263.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	67.	$ 197.	12.48	2458.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		67.	$ 197.		$ 2458.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -255.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -2323.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -2323.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 811.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ -58.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 135.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .03
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 -73.45

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 6003
ENERGY CONSERVATION OPPORTUNITY: ECO- 10
SYSTEM MODIFICATION: OXYGEN TRIM FOR BURNERS
SYSTEMS TO MODIFY: BOILER 1 AND 2

CALCULATION DESCRIPTION:
Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-10, install oxygen trim for burners.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	--	--	71,623	71,623
ECO	--	--	71,173	71,173
Savings (Baseline-ECO)	0	0	450	450

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 0 MMBtu/Yr X $4.0141 /MMBtu = $0 per year

Nat. Gas: 450 MMBtu/Yr X $2.92 /MMBtu = $1,314 per year

Total Energy Cost Savings: $0 + $1,314 = $1,314 per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 0 kW/month X $1.787 /kW X 12 months/year

= (+) $0 per year

Maintenance: = (-) $1,187 per year

Total: $0 - $1,187 = ($1,187) per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-1

** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	71623.
PEAK DAY GAS CONSUMP., 1000 CU FT	703.
ELECTRICAL CONSUMPTION, KWH	976518.
PEAK KW DEMAND (15 MIN BASIS)	417.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	976518.
ON-PEAK KW DEMAND (15 MIN BASIS)	417.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2615
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BOILER ECO-4

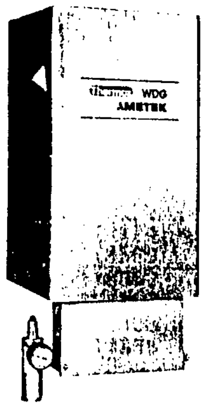
** TOTAL **

SYSTEM C1 NORMAL HEATING AND COOLING LOADS

FUEL AND POWER CONSUMPTION	SYSTEM C1
TOTAL GAS CONSUMP., 1000 CU FT	71173.
PEAK DAY GAS CONSUMP., 1000 CU FT	703.
ELECTRICAL CONSUMPTION, KWH	976518.
PEAK KW DEMAND (15 MIN BASIS)	417.
PURCHASED ELECTRIC POWER	
ON-PEAK CONSUMPTION KWH	976518.
ON-PEAK KW DEMAND (15 MIN BASIS)	417.
MID-PEAK CONSUMPTION KWH	0.
MID-PEAK KW DEMAND (15 MIN BASIS)	0.
OFF-PEAK CONSUMPTION KWH	0.
OFF-PEAK KW DEMAND (15 MIN BASIS)	0.
GENERATED ELECTRICAL POWER KWH	0.
SOLD ELECTRICAL POWER KWH	0.
AUXILIARY FUEL CONSUMPTION	0.
DIR. PROC. GAS CONSUMP., 1000 CF	0.
CHILLER OPERATING HOURS	
CHILLER 1	3672
CHILLER 2	3672
BOILER OPERATING HOURS	
BOILER 1	3624
BOILER 2	2615
RECOVERABLE HEAT USED, MBTU	0.
RECOVERABLE HEAT UNUSED, MBTU	0.

SPECIFICATIONS – AIR-MIZER II SYSTEM

SENSOR



Nominal Dimensions: 14⅝"H x 10¼"W x 10"D (37.2 x 26 x 25.4 cm)

Enclosure: Weather resistant—S.S. case, nickel plated carbon steel base

Weight: 55 pounds (25 kg)

Accuracy: ±1% of net excess oxygen

Repeatability: ±0.2% of measured value

Response: 90% of full scale in less than 5 seconds

Drift: Less than 0.1% of sensor cell output per month

Ambient Temperatures: −5 to +175°F (−20.5 to +79°C)

Sample Temperatures: Up to 1300°F (704°C) with standard probe

Sample Flow Rate: 0.1 to 120 scfh (0.47 to 56.65 liters/minute)

Air Aspirator Requirements: 10 to 20 scfh (4.72 to 14.16 liters/ min) at 15-100 psi (1.05 to 7.037 kg/cm²) (Aspirator air regulator furnished with sensor normally set at 2-7 psi; 0.14 - 0.49 kg/cm²)

Calibration: With analyzed oxygen in nitrogen sample. Calibration port provided.

CONTROL UNIT

Nominal Dimensions: 12⅝"H x 10⅞"W x 9⅛"D (32.1 x 27.6 x 23.2 cm)

Enclosure: Wall/panel mounted—meets the requirements for NEMA 4 areas

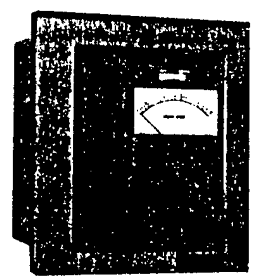
Weight: 22 pounds (10 kg)

Temperature Control: On-Off by microprocessor (±1°C)

Linearization: 256 segments from 20% to 0.2% O_2, (218 from 10% to 0.2%), by microprocessor

Controller Action: On-Off—"On" time adjustable 2-20 seconds. "Off" time adjustable 2-60 seconds.
Deadband: ± 0.25% oxygen.
LED's indicate motor driving.
Will not allow decrease in air when O_2 is below 0.5% oxygen. Air flow will increase to +15% max. if O_2 level is above 12%.

Setpoint: 0 to 10% oxygen by either of: A. Two banks of 5 slide pots, (Dual Fuel) selectable by slide switch; proper pot or pots connected to processor by switch in actuator. B. Manual pot on panel A or B selected by Remote/Local switch on panel. Setpoint indicated by edge reading meter (0-10%)



Manual Control: Manual/Auto switch and increase—decrease push buttons (Spring return switch inside control unit can override all control actions in the event of processor failure).

Ready Indicator: On at temperature set point. Off below temperature set point. Flashes above temperature set point. O_2 Control in "manual" when below set point.

Oxygen Scale: 20.9 to 0.1% O_2 Logarithmic

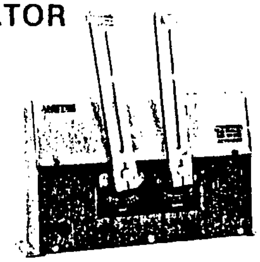
Alarms: High and Low O_2 adjustable 0.2 to 20%. RTD Failure (shuts down temperature control, and puts O_2 control in "manual").

Increase Air Override: Contact closure from optional combustibles or smoke detector alarm will cause increase in air signal on each control pulse regardless or O_2 vs. O_2 setpoint relationship. Once combustibles contact opens, normal control will resume. This maintains air flow at a level where maximum allowable combustibles or smoke is not exceeded.

Ambient Temperature Limits: 32°F to 140°F (0 to +60°C)

Recorder Output: 0-100 mv = 0-20% O_2 Linear (0-50 mv = 0-10%) Other current or voltages outputs optional

ACTUATOR



Overall Size: 17½"L x 4"W x 10¼"H (44.5 x 10.2 x 26 cm)

Weight: 16.5 pounds (7.5 kg)

Angular Travel (Input Arm): 60°

Linear Link Travel: Adjustable 4" to 10" at 4" to 10" Radius (10.2 to 25.4 cm at 10.2 to 25.4 cm Radius)

Linear Link Force: 100 pounds at 4" Radius (45.5 kg at 10.2 cm Radius)
70 pounds at 6" Radius (31.8 kg at 15.2 cm Radius)
40 pounds at 10" Radius (18.2 kg at 25.4 cm Radius)

Case: Suitable for areas requiring NEMA 2 equipment (Drip proof indoor)

Correction: −15% to +15% (.85 to 1.15 gain) of normal air flow

Speed: 60 seconds from −15% to +15% correction (max.)

Load Indication: 9 position shorting switch tied to input arm

Brake: Internal brake will hold load at any above rated force without "coasting"

Ambient Temperature Limits: 0°F to 160°F (−18 to +71°C)

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO. DACA 59-90-C-0087

CODE A | X | CODE B | CODE C

OTHER

EFFECTIVE PRICING DATE APR. 91

DATE PREPARED 08-Apr-91

DRAWING NO.

SHT OF

ESTIMATOR KC

CHECKED BY CEL

PROJECT ENERGY SURVEY OF ARMY BOILER AND CHILLER

LOCATION FT. SILL, OKLAHOMA

BOILER ECO BLDG. 6003

BOILER CONTROL O2 TRIM

TASK DESCRIPTION	Quantity No. Of Units	Quantity Unit Meas	LABOR MH/ Unit	LABOR Total Hrs	LABOR Unit Price	LABOR Cost	EQUIPMENT Unit Price	EQUIPMENT Cost	MATERIAL Unit Price	MATERIAL Cost	TOTAL	SHIPPING Unit Wt	SHIPPING Total Wt
O2 TRIM CONTROL	1	EA			3000	$3,000			$1,800	$9,590	$12,590		
ANNUAL RECURRING COST													
OXYGEN SENSOR	1	EA	0.5	0.5	24	$12			$420	$420	$432		
OTHER MAINTENANCE COST	1	LS							$755	$755	$755		
ANNUAL TOTAL											$1,187		
SUBTOTAL						$3,000				$9,590	$12,590		
OVERHEAD, BOND	16.0%					$480				$1,534	$2,014		
PROFIT	10.0%					$300				$959	$1,259		
COST SUB-TOTAL						$3,780				$12,083	$15,863		
CONTINGENCY	20.0%					$756				$2,417	$3,173		
SUBTOTAL						$4,536				$14,500	$19,036		
S&A	5.5%					$249				$798	$1,047		
TOTAL [illegible]IS SHEET						$4,785				$15,298	$20,083		

DA FORM [illegible]R, APR 85

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: 6003EC10
LCCID 1.035

INSTALLATION & LOCATION: FT. SILL, OKLAHOMA REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: 3002-000 ENERGY SURVEY OF ARMY BOILER/CHILLERS
FISCAL YEAR 1991 DISCRETE PORTION NAME: BOILER O2 TRIM CONTROL
ANALYSIS DATE: 04-10-91 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$	19036.
B. SIOH	$	1047.
C. DESIGN COST	$	1143.
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	$	19103.
E. SALVAGE VALUE COST	-$	0.
F. TOTAL INVESTMENT (1D-1E)	$	19103.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 4.01	0.	$ 0.	8.78	0.
B. DIST	$ .00	0.	$ 0.	12.34	0.
C. RESID	$ .00	0.	$ 0.	12.05	0.
D. NAT G	$ 2.92	450.	$ 1314.	12.48	16399.
E. COAL	$ .00	0.	$ 0.	10.01	0.
F. TOTAL		450.	$ 1314.		$ 16399.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1187.
(1) DISCOUNT FACTOR (TABLE A) 9.11
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -10814.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) /COST(-) (3A2+3Bd4) $ -10814.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 5412.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)= ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YEARS ECONOMIC LIFE)) $ 127.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 5585.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= .29
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 150.42

ENERGY SURVEY OF ARMY BOILER AND CHILLER PLANTS
FT. SILL, OKLAHOMA

CENTRAL PLANT: 6003
ENERGY CONSERVATION OPPORTUNITY: ECO- 15
SYSTEM MODIFICATION: GAS TURBINE ENGINES AND HEAT RECLAIMATION
SYSTEMS TO MODIFY: GAS TURBINE GENERATOR/ HEAT RECLAIM BOILER

CALCULATION DESCRIPTION:

Two PC-CUBE program computer runs are compared to determine the energy savings for ECO-15, install nat. gas turbine engines and heat reclaim.
The first computer run (Baseline) is a simulation of the existing structure, equipment, and systems, and how they are presently operated. The second computer run (ECO) is also a simulation of the existing building with modifications implemented in the systems, equipment, or the operation. The difference in the totals from the two computer runs represents the savings.

ANNUAL UTILITY SAVINGS

PC CUBE RUN	Electric Demand(kW)	Electric Energy(kWh)	Nat. Gas (MMBtu)	Total Energy (MMBtu)
Baseline	417	977,000	15,288	18,623
ECO	0	0	64,891	64,891
Savings (Baseline-ECO)	417	977,000	(49,603)	(46,268)

NOTE: The savings for this ECO did not consider any interrelated savings with other ECOs identified as economically feasible.

ENERGY COST SAVINGS:

Electricity: 3335 MMBtu/Yr X $4.0141 /MMBtu = $13,385 per year

Nat. Gas: -49603 MMBtu/Yr X $2.92 /MMBtu = ($144,841)per year

Total Energy Cost Savings: $13,385 + ($144,841) = ($131,456) per year

NON-ENERGY SAVINGS (+), COST (-):

Demand: 417 kW/month X $1.787 /kW X 12 months/year

= (+) $8,942 per year

Maintenance: = (-) $3,000 per year

Total: $8,942 - $3,000 = $5,942 per year

[ECO-SHT.WK3]

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-2

		GAS DEMAND MCF	GAS CONSUMP MCF	****************** PURCHASED ON-PK DEMAND KW	ON-PK CONSUMP THOU KWH	MID-PK DEMAND KW	ELECTRICAL MID-PK CONSUMP THOU KWH	OFF-PK DEMAND KW	****************** OFF-PK CONSUMP THOU KWH	AUX FUEL CONSUMP	AUX FUEL HRS
C1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	113.	2997.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	112.	3098.	0.	0.	0.	0.	0.	0.	0.	0.
C1	6	114.	2997.	0.	0.	0.	0.	0.	0.	0.	0.
C1	7	112.	3098.	0.	0.	0.	0.	0.	0.	0.	0.
C1	8	113.	3098.	0.	0.	0.	0.	0.	0.	0.	0.
C1	9	113.	2997.	0.	0.	0.	0.	0.	0.	0.	0.
C1	10	112.	3098.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Total gas consumption - May through September, 15,288 MMBtu

PC-CUBE VERSION 2.0.3

CENTRAL PLANT 6003 BASELINE-1

		GAS DEMAND MCF	GAS CONSUMP MCF	ON-PK DEMAND KW	ON-PK CONSUMP THOU KWH	MID-PK DEMAND KW	MID-PK CONSUMP THOU KWH	OFF-PK DEMAND KW	OFF-PK CONSUMP THOU KWH	AUX FUEL CONSUMP	AUX FUEL HRS
				****************** PURCHASED ELECTRICAL ****************							
C1	1	703.	20309.	0.	0.	0.	0.	0.	0.	0.	0.
C1	2	620.	15009.	0.	0.	0.	0.	0.	0.	0.	0.
C1	3	432.	11800.	0.	0.	0.	0.	0.	0.	0.	0.
C1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	5	0.	0.	248.	155.	0.	0.	0.	0.	0.	0.
C1	6	0.	0.	382.	199.	0.	0.	0.	0.	0.	0.
C1	7	0.	0.	414.	221.	0.	0.	0.	0.	0.	0.
C1	8	0.	0.	417.	221.	0.	0.	0.	0.	0.	0.
C1	9	0.	0.	335.	181.	0.	0.	0.	0.	0.	0.
C1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1	11	329.	8592.	0.	0.	0.	0.	0.	0.	0.	0.
C1	12	585.	15913.	0.	0.	0.	0.	0.	0.	0.	0.

Total electrical consumption - May through Septemeber 977,000 kWh
Peak electrical demand - August, 417 kW

PC-CUBE VERSION 2.0.3
CENTRAL PLANT 6003 COGENERATION, ELECTRIC MOTOR CHILLER

		GAS DEMAND MCF	GAS CONSUMP MCF	****************** PURCHASED ELECTRICAL ***************** ON-PK DEMAND KW	ON-PK CONSUMP THOU KWH	MID-PK DEMAND KW	MID-PK CONSUMP THOU KWH	OFF-PK DEMAND KW	OFF-PK CONSUMP THOU KWH	AUX FUEL CONSUMP	AUX FUEL HRS
B1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B1	5	398.	11954.	0.	0.	0.	0.	0.	0.	0.	0.
B1	6	455.	12916.	0.	0.	0.	0.	0.	0.	0.	0.
B1	7	467.	13806.	0.	0.	0.	0.	0.	0.	0.	0.
B1	8	469.	13818.	0.	0.	0.	0.	0.	0.	0.	0.
B1	9	432.	12396.	0.	0.	0.	0.	0.	0.	0.	0.
B1	10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B1	11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B1	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Total gas consumption - May through September, 64,891 MMBtu

APPENDIX E

FIELD SURVEY NOTES

CHILLER-RELATED EQUIPMENT

*

TEST INSTRUMENT INFORMATION

Contract No. DACA 56-90-C-0087.
Energy Study Army Boiler and Chiller Plants at Ft. Sill, Oklahoma.

TEST INSTRUMENTATION USED:

1. Flow meter: Ultasonic flow meter with clamp on probes.
Dynasonics, Inc., Model Mark-3, Series 900, SN
Purchased new August 1990, factory calibrated.
Repeatability, linearity, and system accuracy, see specs.
Used for chilled water and condenser water flow measurements.

2. Water temperature digital thermometers:
Digital thermometer which can measure temperature 1, temperature 2, or delta temperature (T1-T2).
Omega Meter, two, Model HH-23:Z1, SN T-54472 and T-54474.
Temperature probes, four, Model HPS-CASS-14U-12-SMP-M, no SN
Purchased new August 1990, factory calibrated.
Accuracy, see specs.

3. Electric meter: Digital power meter, measures amps, volts, kW, kVAR, KVA, for three phase circuits.
Esterline Angus Power Master III AC Multimeter, SN3182
Calibrated, 9/6/90.
Accuracy, see specs.

4. Temperature and humidity digital meter:
Digital temperature and humidity probe and meter for reading outside air conditions.
General Eastern, Model 800B-2-9-7.
Calibrated, 8/31/90.
Accuracy, temperature +/-0.5oF , relative humidity +/- 2% RH.

5. Combustion gas monitor:
Digital oxygen, CO, and temperature meter for boiler combustion monitoring.
Neotronics, Model 350, Part No. 300-0266-03, SN 0200645.
Purchased new 2/91, factory calibrated.
Accuracy, see specs.

6. Pressure test gauges:
Omega test gauge, 0-100 psig, 0.2 psi subdivisions, accuracy 0.25%.
Omega test gauge, 0-30 psig, 0.1 psi subdivisions, accuracy 0.25%.
Purchased new, 8/29/90, factory calibrated.

Dynasonics, Inc.

Ultrasonic Flowmeter Mark-3™ Series 900

A New, Universal Non-Invasive Flowmeter For Liquids That Require No Solids Or Straight Run Of Pipe.

Dynasonics, a technological leader in Ultrasonic Flowmeters, has engineered all the latest technical advances in one Flowmeter.

☐ **Prompting Microprocessor**
- Self-Instructing Data Entry • Rate Readout in GPM, FPS, MGD, or Metric
- Volume Readout in Gals., or Metric • Set Span for 4-20 ma Output
- Select Damp Range • Rate and Total Volume Displays always indicate Units Selected
- Battery Backed Up Parameter Memory

☐ **Digital Filtering; Auto Frequency Tracking**
- Tracks and Locks on Desired Frequency • Eliminates Undesired Error Frequencies
- Linearizes Turbulent/Unsymmetrical Flows • Allows Mounting Transducers without Straight Pipe Runs

☐ **Auto Damping**
- Auto Adjusts Damping to Flow Rate Change
- Provides Steady Repeating at Stabilized Flow
- Rapidly tracks significant Flow Change
- Dynamic Process Tracking

☐ **Easy Operation**
- Light Weight—Less than 18 Lbs.
- Operates with Cover Closed
- Self-Contained Battery w/charger
- One Hand Transducer Strap On

☐ **Cost Effective**
- Cost Reduction for Survey Measurements—Non-invasive
- Lower Cost than Flowmeters Producing Comparable Measurements
- Flow Measurements in Several Minutes, Without Special Pipe Preparation
- Virtually All Liquids, Independent of their Physical or Chemical Properties

M3-902 PORTABLE SURVEY FLOWMETER (With Microprocessor)

T-903 TRANSDUCERS (Easy Strap-on)

APPLICATION NOTE

DATE: 11/88
REVISED: 4/89
NUMBER: 1009

SPECIFICATIONS
M3-900 FLOWMETER
ULTRASONIC DOPPLER FOR CLEAN AND DIRTY LIQUIDS

GENERAL

The flowmeter shall be the latest state-of-the-art ultrasonic design utilizing the phase shift method, not requiring any suspended solids for operation. It will provide indicating and transmitting of flow rate in a full pipe. The operational specifications shall be: electronics repeatability and linearity, +/-.1% full scale, total system accuracy of +/-5%. Unit can be field calibrated to 1% of field reference.

The meter shall operate on, but not be limited to the following pipe materials: carbon steel, ductile iron, cast iron, FRP and PVC. The ultrasonic flowmeter shall not require a spool section and shall operate on a straight section of pipe having homogeneous construction. Each meter shall respond to changes in flow when the medium is clear or contains suspended particles.

FLOWMETER ELECTRONICS

The electronics shall be housed in a NEMA IV enclosure and shall operate at temperatures between 0°C and 50°C. All electronic circuits will be coated with a mil-spec anti-fungus compound. The front of the housing shall be hinged to provide easy access to all controls and be suitable for wall or pipe stand mounting. The transmitter/indicator shall be capable of being calibrated for different flow ranges on 1" through 60" pipe sizes without replacement of any metering or sensing component. The transmitter shall include adjustment for mA span, mA 0, signal damping and for range calibration. The transmitter/indicator shall contain an internal range switch enabling the flow rate to be changed from 5, 10, 20 FPS. The flowmeter's electronic calibration can be checked by the optional microprocessor which induces a calibration frequency to assume full scale flow. The flowmeter electronics shall be powered by 120 VAC at 50/60 Hz.

A transformer isolated 4-20 mA output shall be provided and be proportional to flow. The maximum resisted load shall be 600 ohms. Output current limiting circuitry shall be provided.

P.O. Box 667 • 522 W. Fifth Avenue • Naperville, IL 60540 • 312/355-3055 • Fax–312-355-9408

M3-900 SPECIFICATIONS - PAGE 2

The transmitter shall include recognition circuits to condition the signal being generated by the transducer. A digital filtering system shall discriminate between the desired linear signals and the non-linear signals at a point of non-symmetrical turbulence that is downstream of an elbow for accurate measurement of clean liquid applications. Unit's fault and read indication will verify operation on application.

<u>TRANSDUCER</u>

The electronic flow sensing devices (transducers) shall be capable of being mounted to the outside of the pipe installed and removed without interrupting flow in the line. The transducers shall be of the piezo-electric type; one transducer with a transmit crystal, the other with a receive crystal. The transducers shall be designed to operate continuously at temperatures of up to 180°F. An adjustable strap shall be provided as a means of quickly mounting and demounting transducers.

The sensing element (transducer) shall be supplied as a dual weatherproof assembly with 20 ft. of flexible armoured conduit and shall be mounted on the pipe according to the manufacturer's recommendations.

<u>MANUFACTURER</u>

The ultrasonic clean water flowmeter shall be the Dynasonics Model M3-900 or a pre-approved equal.

<u>INSTALLATION SERVICES/START-UP</u>

The manufacturer's agent shall demonstrate like portable equipment to ensure that the correct doppler flowmeter is selected for the user's application.

The Exceptional Digital Thermometers

Models HH-22:Z1 and HH-23:Z1

- **0.1° Resolution in °F/°C for J, K, and T**
- **Dual Input with T1, T2 and Δ T Measurement**
- **High Accuracy**
- **Trend Indication and Display Hold**
- **Max/Min Storage of T1, T2 and Difference**
- **Retention of User Programming**

The HH-22 and HH-23 microprocessor-based digital thermometers are exceptional instruments, with innovations not previously available in a handheld. Innovations like a trend display and self-diagnostics, combined with 0.1% of reading accuracy, 0.1° F/C resolution, dual input, differential measurement, display hold, J, K and T type thermocouple inputs, and min/max data storage make the HH-22 and HH-23 extraordinary values.

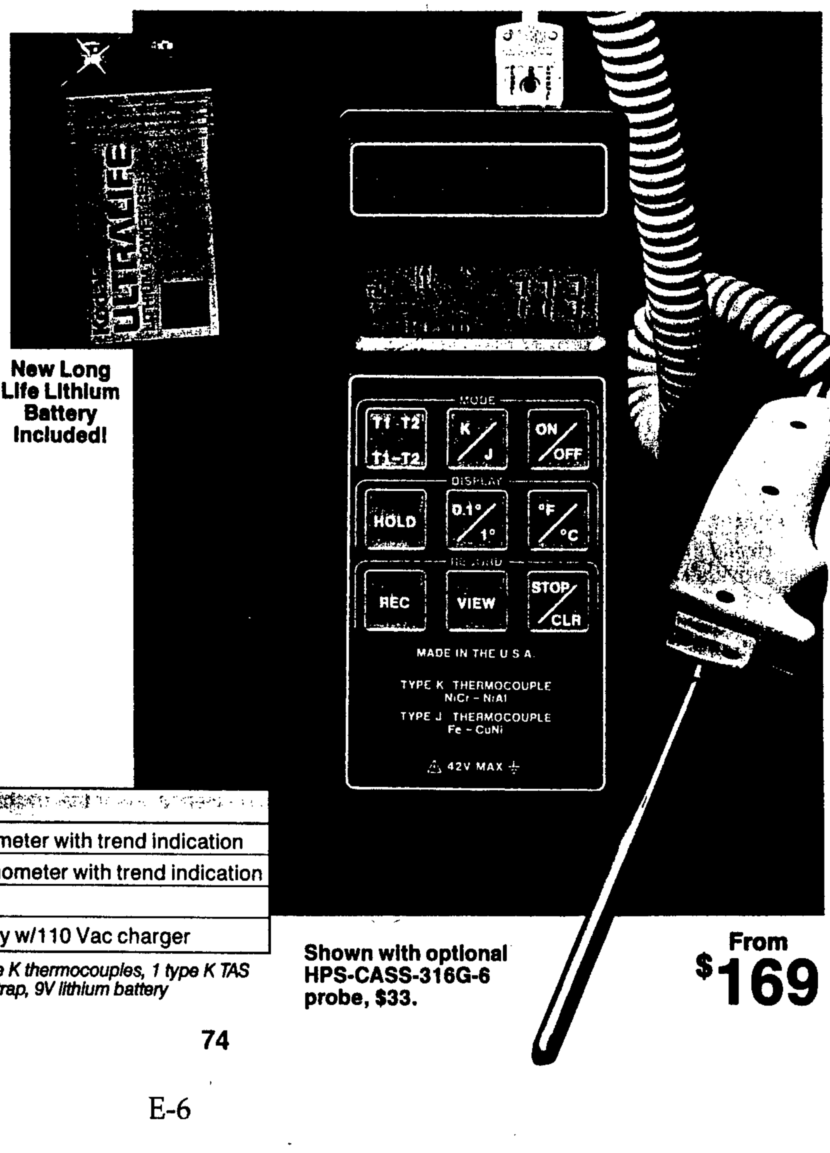
These instruments are truly user-friendly. User-selected features, such as thermocouple type and units, are retained by the unit when power is shut off; when turned back on, the unit remembers these parameters, so reprogramming isn't necessary.

High accuracy and field portability are combined in the HH-22 and HH-23. Along with the other features, the case is drop, splash and dust proof, and has a built-in tilt stand/hanger for bench use or hands-free field measurements.

MADE IN **USA**

SPECIFICATIONS

Inputs: thermocouple, types J and K (HH23 has J/K/T)
Display: 5 digit LCD; custom indicators for input selection and type, units, HOLD, trend arrows, REC, MIN, MAX, VIEW, BAT
Keypad: 9 momentary switches with tactile feedback that select power, input type, units, resolution, hold, record/view min/max, stop/clear recording
Power Off Configuration Retention: retention of selected readout, input type, units and resolution
Diagnostics: low battery, open thermocouple, invalid keypad entry, out of range, internal hardware fault
Dimensions: 7.0″H x 2.9″W x 1.1″D
Weight: 10 oz
Repeatability: 0.2°C
Range, Type K: −328 to 2502°F; −200 to 1372°C
Range, Type J: −346 to 1400°F; −210 to 760°C
Range, Type T (model HH23 only): −328 to 752°F; −200 to 400°C
Resolution: 0.1° throughout entire range
Accuracy: ±(0.1% rdg + 1.0°F)
Temperature Coefficient: 64 to 82.4°F, included in accuracy; 32 to 64°F and 82 to 122°F: ±(0.02% rdg + 0.1°C)/°C
Operating Environment: 32 to 122°F, 0 to 80% RH
Reading Rate: 1 per second
Max. Common Mode Voltage: 42 V peak to earth ground
Power: 9 Vdc battery
Battery Life, Continuous: 200 h typical, lithium battery



New Long Life Lithium Battery Included!

Shown with optional HPS-CASS-316G-6 probe, $33.

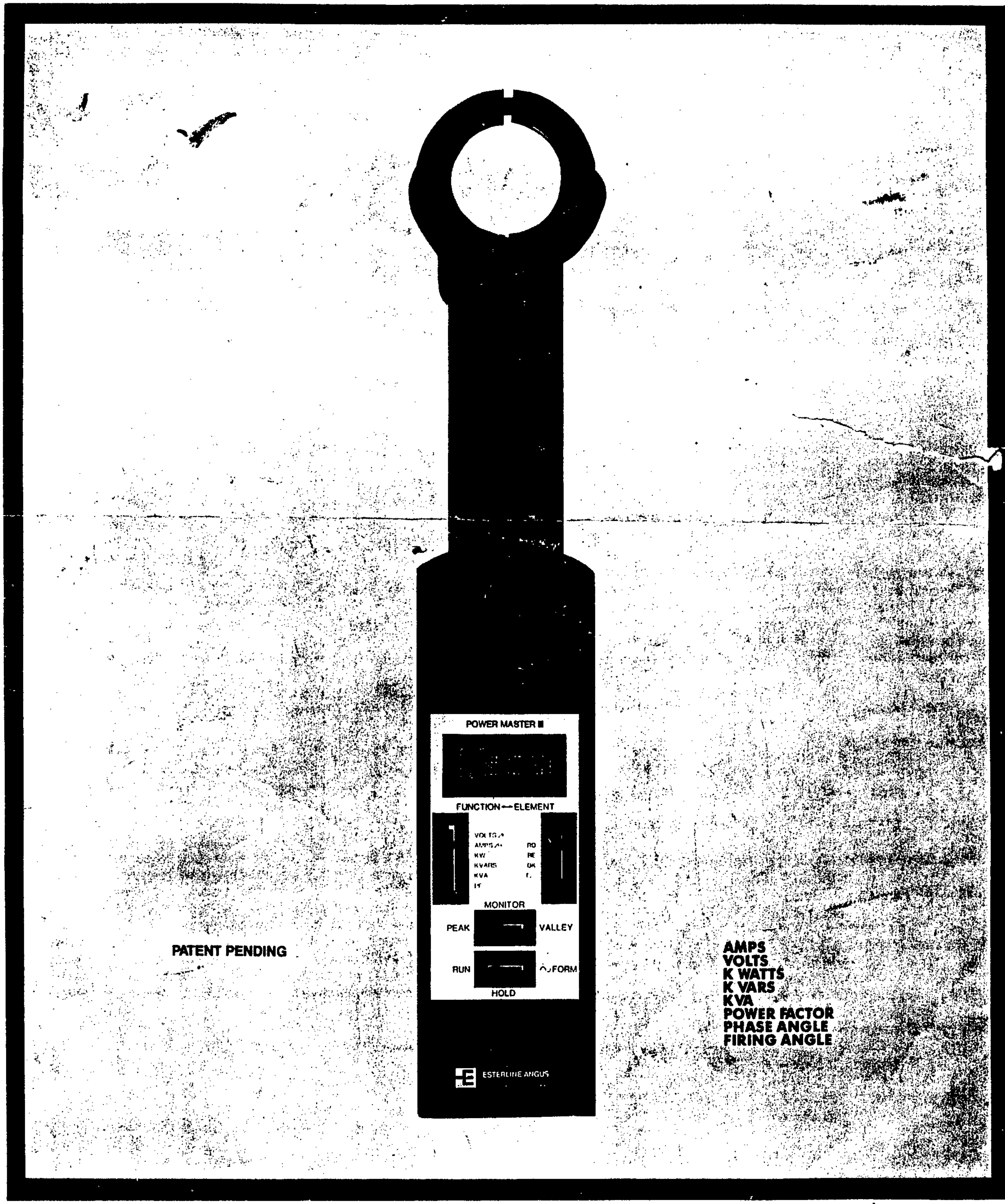
From $169

How to Order

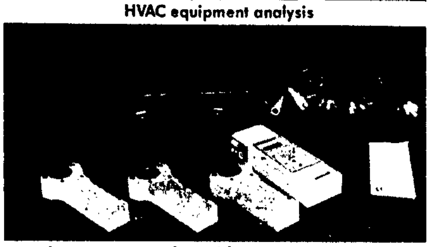
Model No.	Price	Description
HH-22:Z1	$169	J/K Digital Thermometer with trend indication
HH-23:Z1	189	J/K/T Digital Thermometer with trend indication
SC-800:Z1	10	soft carrying case
HH22-AC:Z1	30	9 Vdc NiCad Battery w/110 Vac charger

Each unit comes complete with 2 beaded wire type K thermocouples, 1 type K TAS transition adaptor, integral tilt stand/handle, wrist strap, 9V lithium battery

Esterline Angus Power Master III AC Multimeter

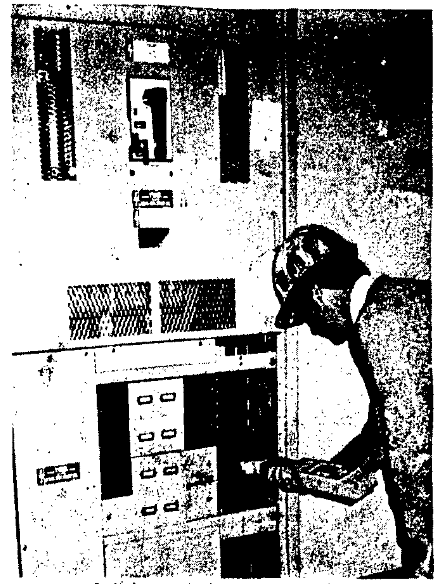


HVAC equipment analysis



Instrument complete with case and optional package for polyphase measurements.

Light circuit load survey analysis for commercial and industrial complexes



Switch gear 3-phase circuit analysis

Model No. PM III

The Esterline Angus Power Master III AC Multimeter will measure all AC parameters on single and three-phase (balanced or unbalanced) power circuits. A process utilizing three full elements is employed, with transformer isolation built-in.

This highly versatile device uses a microprocessor to sample, square, average and square root the input waveform for true RMS voltages and currents. Voltage and current inputs are sampled simultaneously, then processed to provide readings in kw, kvar, kva, and Power Factor. An additional memory process is utilized to provide phase angle (sequence) and voltage firing angle for SCR analysis. This capability makes the device a must for checking distribution networks, panels, and individual loads, plus SCR controller operations.

All AC parameters measured can be read on the liquid crystal display and/or remotely recorded through the signal output jack. Individual voltages or currents, and single or total measurements of polyphase power parameters can be switch-selected. A HOLD switch position is provided to lock-in an instantaneous reading. Peak and Sag readings can also be recalled.

Specifications

Measurements:
Voltage: To 600 VAC (rms)
Current: To 1000 AAC (rms)
Watts: 600 kw per element, 1800 kw total (3 el)
VARS: 600 kvar per element, 1800 kvar total (3 el)
Volt-Amperes: 600 kva per element, 1800 kva total (3 el)
Power Factor: 0.0 lag—1.0—0.0 lead, 1Ø or 3Ø, in percent
Current Transformer: Clamp-on type operated by integral lever. Accepts 2" dia. wire or ½" x 2" rectangular bus.
Case: Hi-impact plastic case with detachable current transformer.
Overall Dimensions: 1⅞" D x 3½" W x 20" L (11" L without current transformer)
Weight: 2.5 pound-PM III
1.5 pound-Transformer
Temperature: Operating: 0° to 50°C (32° to 122°F)
Storage: −20° to 75°C (−4° to 167°F)

Individual elements have color-coded input terminals, which are recessed for safety. Unit is battery powered, and will operate 15 hours continuously on one set of batteries.

Frequency range: 45-66 Hz, 400 Hz
Accuracy:
Volts: ± 1% Reading ± 0.3% FS ± 1 digit
Amperes: ± 1% Reading ± 0.3% FS ± 1 digit
kw/kvar: / **kva:** 1Ø ± 2% Reading ± 0.4% FS ± 2 digits
3Ø ± 3% Reading ± 0.4% FS ± 2 digits
Accuracies given are for currents above 10A.
Add 4% Reading accuracy for 400 Hz.

			45-66 Hz	400Hz
Power Factor:	1Ø and 3Ø	±0.9-1.0	1% P.F.	4%P.F.
		±0.0-±0.9	2% P.F.	8%P.F.

Power Factor accuracies are for currents above 20A.

Reading update: Every 3 seconds for 1Ø, every 6 seconds for 3Ø.
Recorder output: 0-±1mA with up to 2k ohm load, accuracy ± 0.5%. Output at jack is same as parameter being displayed. (Except phase sequence and firing angle).

Voltage and current waveforms can be selected for waveform analysis on recorder output. Note: Accuracies stated above are for sinusoidal waves. SCR controllers with firing angles up to 120 degrees will have up to 4 percent additional inaccuracy.

The Power Master III AC Multimeter package includes a basic meter, one attachable current transformer, a set of 3-foot-long color-coded current and potential leads, one instruction manual, and a carrying case. Specify Model No. PM III. An optional package is available for polyphase circuit measurement, and consists of two additional current transformers, with color-coded current and potential leads. Specify Model No. PM III-Aux. The standard carrying case accommodates all hardware for polyphase measurements.

ESTERLINE ANGUS
AN ESTERLINE COMPANY

Esterline Angus Instrument Corporation
Box 24000, Indianapolis, Indiana 46224
Tel. 317-244-7611
Cable: Estango Telex: 027-419

E I L®
INSTRUMENTS, INC.

Certificate of Calibration

MODEL NO. *PMIII* **SERIAL NO.** *3182*
INSTRUMENT *Multimeter* **MANUFACTURER** *Esterline Angus*
Accuracy: per mfgs specs

Calibration traceable to the National Institute of Standards and Technology in accordance with MIL-STD-45662A has been accomplished on the above-named instrument by comparison with standards maintained by E.I.L. Instruments. The accuracy and stability of all standards maintained by E.I.L. Instruments are traceable to national standards maintained by the National Institute of Standards and Technology in Washington, D.C. and Boulder, Colorado. Calibration was accomplished at a temperature of *70°F* and at a relative humidity of *51* per cent.

Complete record of all work performed is maintained by E.I.L. Instruments and is available for inspection upon request. The instrument ~~was~~/was not out of tolerance when initially received by E.I.L. Instruments, Inc.

Calibration Report No. *233483* Dated *9/6/90*
Date Due 9/6/91

Certified by: [signature]
Quality Assurance Manager

Traceability Data:

THOMAS 1 OHM STANDARD, NBS #240160, SEP 10, 1987
1000 PICOFARAD CAPACITOR, NBS#242521, AUG 31, 1988
100 MILLIHENRY INDUCTOR, NBS #241713, MAY 10, 1988
GUILDLINE STANDARD CELL, NIST #243346, JUN 12, 1989
AC/DC TRANSFER STANDARD, NBS #239605, JAN 10, 1989
WWV TIME STANDARD, WWVB BY RECEIVER COMPARISON
RF POWER STANDARD, NBS #2453A0676-001, DEC 21, 1988

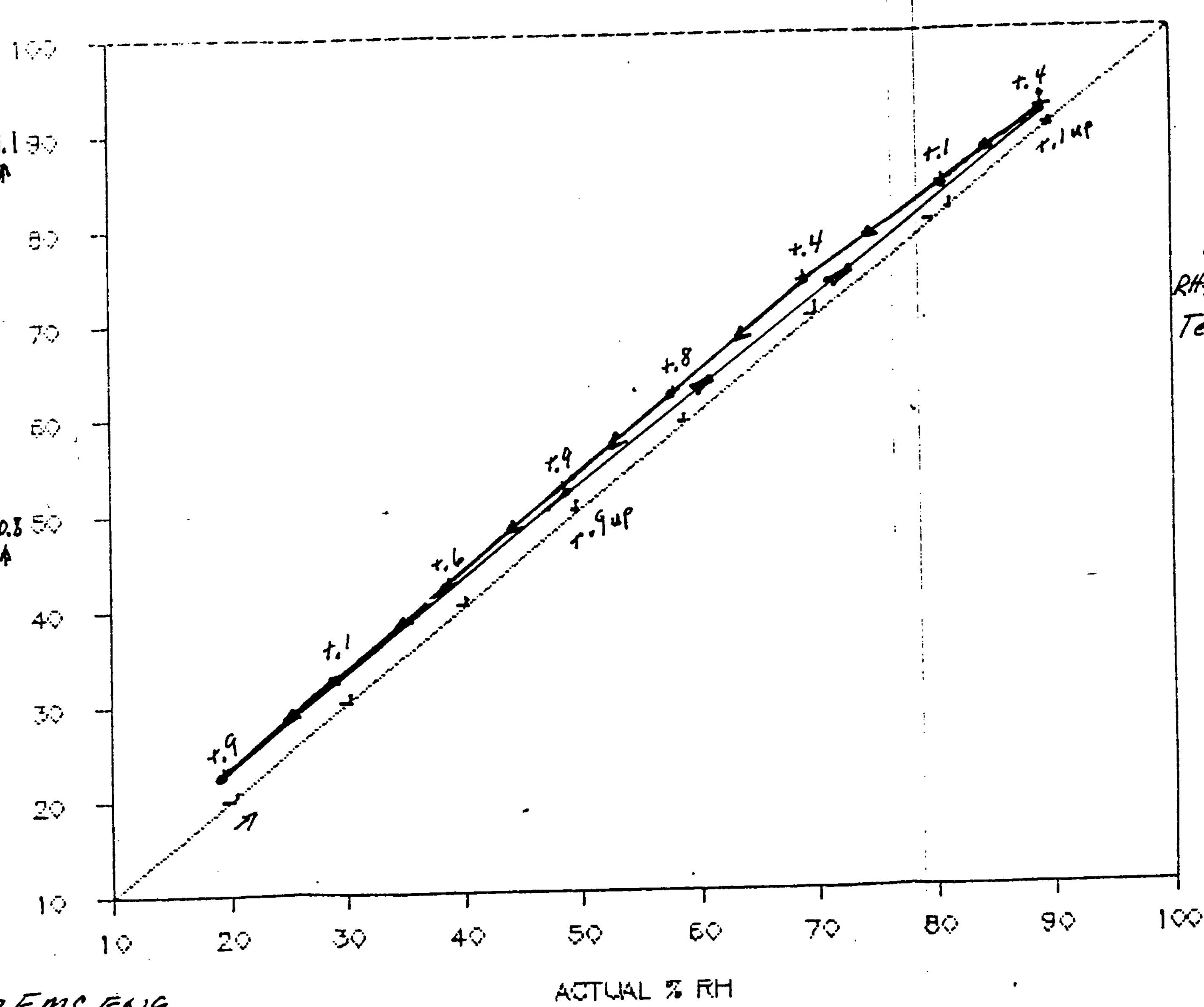
Form 401, Rev. 5/88

STANDARD
GEI 15[illegible] YGRo Computer
SERIAL 4581
1211/P
S/N 3691
C-1 24745

Integrated S[illegible] Techand
8/31/90

RH

%RH 1500	800 B	
90.6	91.0	91.1
80.9	81.0	
71.0	71.4	
60.8	61.6	
49.6	50.5	50.8
40.7	40.1	
31.5	31.6	
21.8	22.7	



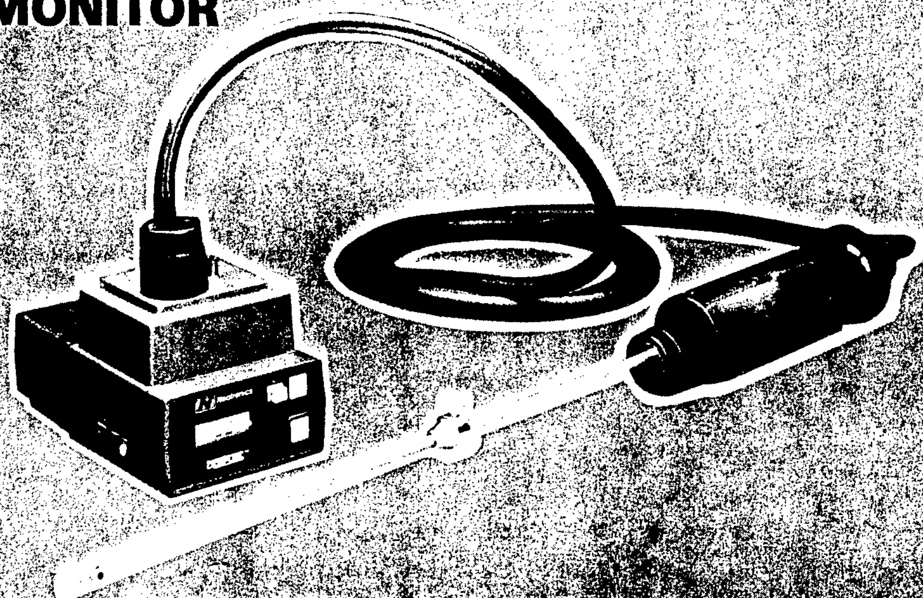
Hysteresis = < .16%
RH ACCURACY < .9%
Temp = Accur < .5

UNIT UNDERTEST
MODEL 800 B-2-9-7 EMC ENG
SERIAL N/A
DATE 8-31-90
% DEVIATION < .9% RH FS Temp = < .4% FS.

OPTIFUEL®

MODEL 250 and 350

COMBUSTION GAS MONITOR



USER MANUAL

NEOTRONICS

A Member of the Neotronics PLC Technology Group

1.2 Specifications

Power: Custom NiCad Battery Pack 4.8V 2.0Ah
Battery Life: 12 hours typical (continuous operation)
Charge Time: 12 to 16 hours with OPTiFUEL Charger
Display: 3 digit, 8mm Liquid Crystal Display
Operating Temperature: 0°C (32°F) to 50°C (122°F)
Storage Temperature: −10°C (14°C) to 55°C (131°C)
Probe Temperature: 500°C continuous operation 1000°C max
Warm-up Time: 40 seconds AUTOCAL routine
Response Time: (To 80% of true reading when used with 3m of tubing, probe and filters)
Oxygen: less than 25 seconds
Carbon Monoxide: less than 40 seconds

Display Ranges and Resolution:

Parameter	Range	Resolution
Oxygen	0 to 32.0%	0.1%
Carbon Monoxide **(Autoselected)**	0 to 999 ppm 0 to .999% 0 to 5.00%	1 ppm 0.001% 0.01%
OPTiFUEL 350		
Temperature	−20° to 999° (F or C)	

E-12

Accuracy: (with normal operating conditions)
Oxygen: Better than ±0.4% of Oxygen ±1 count
Carbon Monoxide: Better than ±5% of reading ±1 count
OPTiFUEL 350
Temperature: Maximum = Thermocouple error ±3% of reading ±1 count
Typical = ±1.5% ±1 count

Case: Heat-Resistant High Impact ABS
Dimensions: 180mm × 100mm × 95mm (including battery pack)
Weight: Less than 1 kg (including battery pack)

Note: Typical commerical thermocouple error:

±2.2°C (−20° to +227°C)
or ±0.75% (±227°C to +1260°C)

CHAPTER 2 OPERATION OF THE OPTiFUEL

2.1 Switch on

The OPTiFUEL monitor is supplied with its (fully charged) battery pack already connected. If the monitor has been in use and the battery is discharged, recharge the battery before using the monitor or use the monitor with the charger connected. Chapter 3 contains instructions for charging and mains operation.

IMPORTANT NOTE: MAKE SURE THAT THE OPTiFUEL IS IN CLEAN FRESH AIR BEFORE SWITCHING IT ON. THIS IS VERY IMPORTANT AS THE "AUTOCAL" ROUTINE WILL ADJUST THE CALIBRATION OF THE OPTiFUEL INCORRECTLY IF THE AMBIENT AIR IS NOT CLEAN AND FRESH.

Switch the OPTiFUEL on by firmly depressing (and releasing) the "Power On/Off" button. DO NOT connect the probe, filters or tubing to the instrument at this time.

At switch on the OPTiFUEL displays a software code which identifies which version of software is built in. In an OPTiFUEL 350 PO8 monitors Farenheit and PO7 monitors Celsius. PO6 is an OPTiFUEL 250. All segments of the display will then momentarily illuminate and the pump will start operating. The pump generates a characteristic purring noise.

The instrument will now enter its 'AUTOCAL' mode. The display will flash an alphanumeric 'CAL'.

2.2 'AUTOCAL' Mode

When the OPTiFUEL is first switched on it enters the 'AUTOCAL' mode. In this mode the instrument's microprocessor assumes that the ambient conditions are that of fresh air (20.9% Oxygen and 0 ppm Carbon Monoxide). The microprocessor sets the Oxygen Span and Carbon Monoxide Zero calibration for these values.

While the OPTiFUEL is in AUTOCAL mode the display flashes 'CAL'. After approximately 40 seconds the instrument enters its Oxygen display mode (see section 2.5).

This automatic calibration adjustment can only be achieved if the two measured parameters are within a capture range "window". If the instrument is switched on with gas applied, or there is a fault, the measurement will be outside of the "window" and an error message will be displayed (see section 2.8b or 2.8c).

2.3.1 Sample System Connection for OPTiFUEL 250

Only connect the sample system aft OPTiFUEL has completed its AU routine.

Connect the probe to the inlet end filter housing.

Connect one length of tubing betwe OPTiFUEL "inlet" port and the dust filt arrow on the filter shows the direction flow. This arrow must point towar OPTiFUEL.

Connect the second length of gas between the other end of the dust filt the filter housing.

Adjust the sealing sleeve for the le probe required and insert the probe i sampling hole. The sleeve acts as both and a seal (for larger holes). Figs 2.3. 2.3.1.b illustrate the use of the sleev

Fig 2.3.1.a

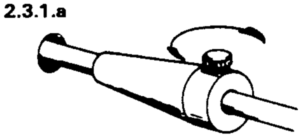
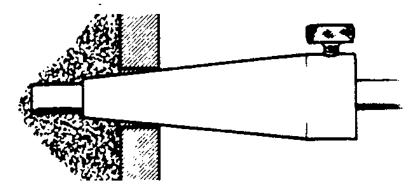


Fig 2.3.1.b



Figs. 2.3.1.a and 2.3.1.b Use of the probe

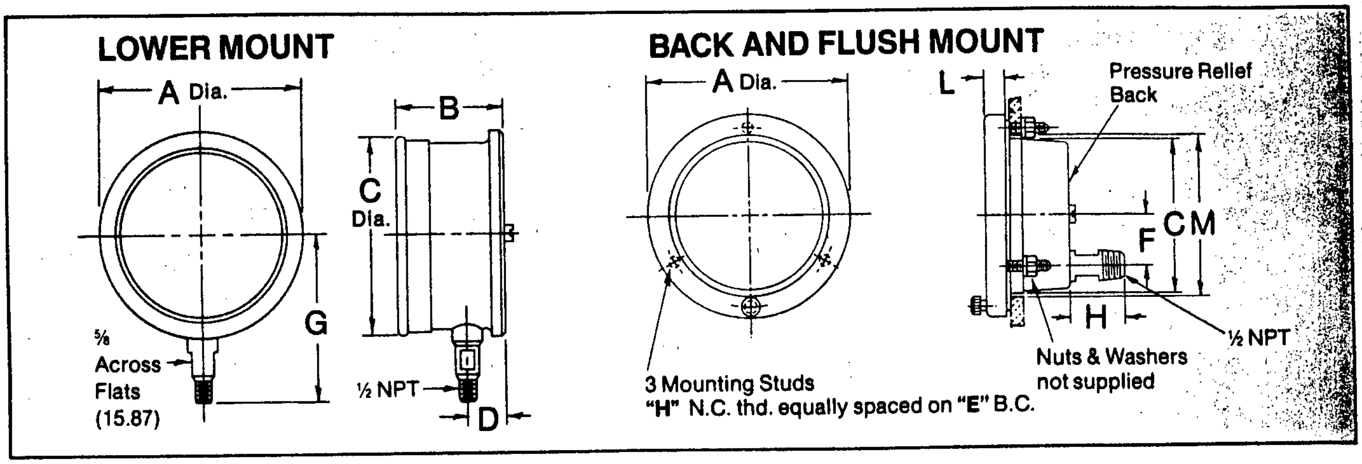
2.3.2 Sample System Connection for O 350

As for the OPTiFUEL 250 only co systems after the instrument has c its AUTOCAL routine.

If the probe is not connected to th ment the temperature reading unstable, ignore any temperature when the probe is not connected.

Connect the system as indicated in F that is: Instument MALE to Extens

TEST GAUGES—HIGH ACCURACY AND 316 STAINLESS STEEL WETTED PARTS



LOWER MOUNT

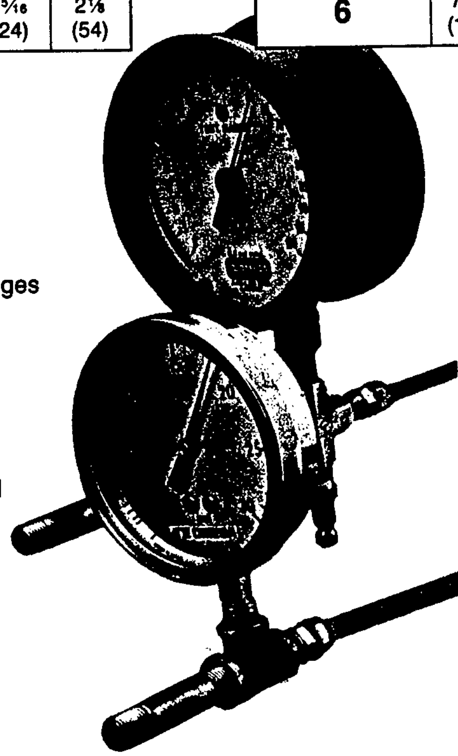
Dial Size Inches	A	B	C	D	G
4 1/2	5 1/16 (129)	2 37/64 (65)	5 1/16 (129)	15/16 (24)	3 13/16 (97)
6	6 11/16 (170)	2 19/32 (66)	6 37/64 (167)	15/16 (24)	2 1/8 (54)

BACK AND FLUSH MOUNT

Dial Size Inches	A	C	F	H	L	M
4 1/2	6 1/16 (154)	4 13/16 (122)	1 5/8 (41)	1 7/8 (48)	5/8 (16)	4 7/8 (124)
6	7 9/16 (192)	6 5/16 (160)	2 1/8 (54)	1 7/8 (48)	5/8 (16)	6 1/2 (165)

SPECIFICATIONS

Case: Solid Aluminum with Epoxy-coated Finish
Lower Connection: Green Finish
Back Connection: Black Finish
Window: Glass
Movement: Stainless Steel
Bourdon Tube: 316 Stainless Steel thru 3000 PSI; Monel,5000 and 10,000 PSI ranges
Connection: 316 Stainless Steel
Fitting: 1/2" NPT
Dial Size: 4 1/2" with White Background, black graduations and mirror band.
Mounting: Stem: Lower Connection
Panel or Stem: Back Connection
Accuracy: 0.25% FS
Ring: Lower Connection Model–Threaded Aluminum Back Connection Model–Mounting Flange With Hinged Cover Ring Secured By Knurled Screw
Safety Features: Solid Front With Pressure Relief Back



The OMEGA Test Gauges are highly accurate gauges designed for use in instrument shops, plants of all types, and laboratories throughout industry. Performance, reliability, and precision measurement are coupled with consistent accuracy in meeting the demanding service needs of various test gauge applications such as for use as a master reference gauge, in test stand measurements, for production inspection, and for verifying accuracy of general service gauges. The dial has a stainless steel mirror ring for pointer reflection to prevent parallax error. This mirror surface reflects the pointer in any position and allows the gauge to be read with great accuracy. The lightweight, friction adjustable balanced pointer with knife edge tip, assures easy reading to the smallest subdivision. The accented dial graduations have a true width equivalent to 0.25 percent tolerance for quick and accurate gauge checking.

Warning: All gauge components should be selected considering media and ambient operating conditions to prevent misapplication. Improper application can be detrimental to the gauge, cause failure, and possible personal injury or property damage.

Ordering Example PGT-45 □ –Range Code

1. **Pressure Gauge, Test Type**
2. **Dial Size 4 1/2"**
3. **Connection–Lower (L) or Back (B)**
4. **Range Code–see pg. G-24**

For Complete Listing of Stocked Test Gauges Refer to pg. G-24

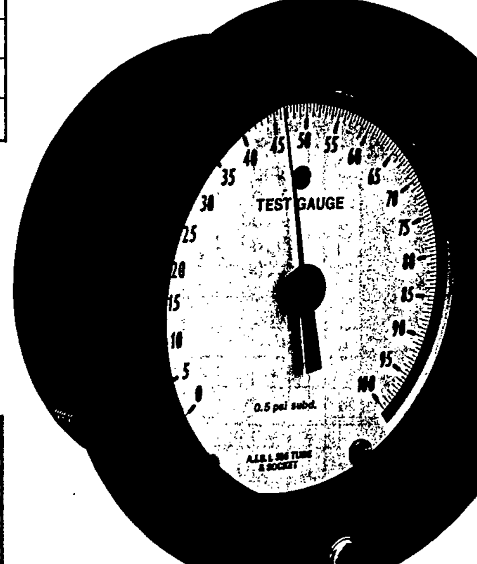
TEST GAUGES 4½″ AND 6″ DIALS TYPE T

MADE IN USA

How To Order Type T — Test Gauges

Dial	Model	Connection	Vacuum to 1000 PSI	Price 1500 to 3000 PSI	5000 and 10000 PSI
4½″	PGT-45L-[*]	Lower	$195	$225	$240
	PGT-45B-[*]	Back	195	225	240
6″	PGT-60L-[*]	Lower	231	282	341
	PGT-60B-[*]	Back	231	282	341

*Insert Range Code from table below.
Options: (Add suffix to part number)
-X6B Gauge cleaned for oxygen service **$62**
Ordering Example: PGT-45B-300: Pressure Gauge, Test Type, 4½″ Dial, Back Connection, 0/300 PSI Range Price: **$240.**



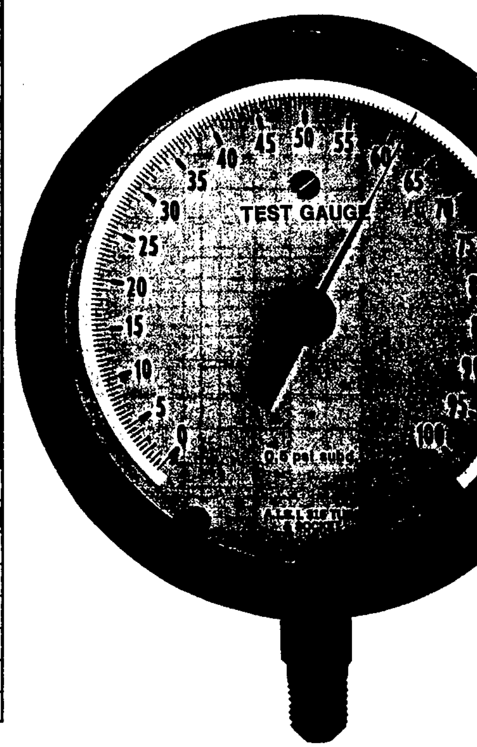
STYLE B

Standard PSI Ranges Type T

RANGE CODE	RANGE	FIGURE INTERVAL	MINOR GRADUATION
15	0/15	1	0.05
30	0/30	2	0.1
60	0/60	5	0.2
100	0/100	5	0.5
150	0/150	10	0.5
200	0/200	10	1
300	0/300	20	1
400	0/400	20	2
600	0/600	50	2
800	0/800	50	5
1000	0/1000(1)	50	5
1500	0/1500	100	5
2000	0/2000	100	10
3000	0/3000	200	10
5000	0/5000	500	10
10,000	0/10,000	1000	50
Vacuum			
30V	30/0″ Hg	2″ Hg	0.1″ Hg
Compound			

Range Code	Range (Inchs Mercury / PSI)	Figure Interval inchs Hg	Figure Interval PSI	Minor Graduation inchs Hg	Minor Graduation PSI
30V/15	30″ Hg Vac/0/15 PSI	5	2	0.25	0.1
30V/30	30″ Hg Vac/0/30 PSI	10	5	0.5	0.2
30V/60	30″ Hg Vac/0/60 PSI	10	5	1	0.5
30V/100	30″ Hg Vac/0/100 PSI	10	5	2	0.5
30V/150	30″ Hg Vac/0/150 PSI	30	10	2	1
30V/200	30″ Hg Vac/0/200 PSI	30	20	2	1
30V/300	30″ Hg Vac/0/300 PSI	30	20	5	1
30V/400	30″ Hg Vac/0/400 PSI	30	20	5	1

See page G-23 for special metric ranges.



STYLE L

♦ ***HIGHLIGHTED MODELS STOCKED FOR FAST DELIVERY*** ♦

NAME PLATE INFORMATION
FOR
CHILLER, CW & CNW PUMPS, AND COOLING TOWER
(LISTED BY CENTRAL PLANT)

BLDG 730 CHILLER 1

TYPE: 800 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 460V, 1650LRA, 821A, 3PH, 60Hz

MANUFACTURER: TRANE SERIAL #L83H13856
MODEL #CVHE-089F-AD-2WB2705DALC15DB-GC0000000061J00

REFRG TYPE: R-11

YEAR INSTALLED: 1983 (SPREADSHEET)

BLDG 730 CHILLER 3

TYPE: 320 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 480V, 797LRA, 367A, 3PH, 60Hz

MANUFACTURER: TRANE
MODEL #CVHA-032G-HF-16JF2AZAF25AZA51100
SERIAL #L80A06559

YEAR INSTALLED: 1980 (SPREADSHEET)

COMMENTS: ONLY RUNS IN SPRING & FALL WHEN CHILLER 1 (800 TON) IS NOT NEEDED.

BLDG 730 CHILLER 4

TYPE: 320 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 480V, 797LRA, 367A, 3PH, 60Hz

MANUFACTURER: TRANE
MODEL # SAME AS CHILLER 3
SERIAL #L80A06558

REFRG TYPE: R-11

YEAR INSTALLED: 1980 (SPREADSHEET)

COMMENTS: DOES NOT RUN BECAUSE OF A LEAK.

BLDG 730 CW PUMP 1

SERVES CHILLERS 1 & 3 FOR BLDG 730 ONLY

MOTOR
NAMEPLATE: 220/440V, 62 /31AMP, 3PH, 60Hz, 25 HP, 1750RPM

FRAME GROUTED? NO

BLDG 730 CW PUMPS 1 & 2

SERVES CHILLERS 1 & 3 FOR OTHER 700 AREA BLDGS.

MOTOR
NAMEPLATE: 460V, 179AMP, 3PH, 60Hz, 150HP, 1780RPM

FRAME GROUTED? NO

PUMP TYPE: PACO CAT #29-60196-050101 S #LWMF9912OA
GPM: 1000 TDH-FT: 290
IMP-DIA: 16.51"

PRESSURE TAPS ON: SUPPLY, RETURN

BLDG 730 CNW PUMPS 1 & 2

SERVES CHILLER 1 & 3

MOTOR
NAMEPLATE: 220/440V, 118/59AMP, 3PH, 60Hz, 50HP, 1760RPM

FRAME GROUTED? YES

PUMP TYPE: AURORA NO: 138230; TYPE: OJ; GPM: 200; TDH-FT: 75
RPM: 1750
DIM: 855X8

PRESSURE TAPS ON: SUPPLY, RETURN

BLDG 730 CNW PUMP 3

SERVES CHILLERS 1 & 3

MOTOR
NAMEPLATE: 200V, 90AMP, 3PH, 60Hz, 30HP 1760RPM

FRAME GROUTED? YES

PUMP TYPE: PACIFIC CAT #29-60122-040001-102
GPM: 1300 TDH-FT: 75
SERIAL: JLR28808

PRESSURE TAPS ON: SUPPLY, RETURN

BLDG 730 COOLING TOWER FOR CHILLERS 1 & 3

MANUFACTURER: MARLEY DOUBLE FLOW MODEL #N/A
SERIAL #(452) 41008 75

NO. OF FANS: 2 230/460V, 71.4/35AMP, 3PH, 60Hz, 30HP

YEAR INSTALLED: 1980 (SPREADSHEET)

COMMENTS: COOLING TOWER WATER LEVEL TOO LOW OR SEPARATING BOARD TOO HIGH.

BLDG 914 CHILLER 1

TYPE: 400 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 460V, 711LRA, 339A, 3PH, 60Hz

MANUFACTURER: TRANE MODEL #CVHE-045F-CT-2LC235ECEIAIIDEEC-00000AIA25ZIAOCPL4533-9045-01
SERIAL #L89J03103

REFRG TYPE: R-11

YEAR INSTALLED: 1989 (SPREADSHEET)

BLDG 914 CW PUMP 1

SERVES CHILLER 1

MOTOR
NAMEPLATE: 230/460V, 95.4/48AMP, 3PH, 60Hz, 40HP, 1775RPM

MOTOR TYPE: US ELECTRIC TYPE: CT FRAME: 324TTE
ID #F208/807S115R031R-10

FRAME GROUTED? YES

PUMP TYPE: N/A

PRESSURE TAPS ON: SUPPLY, RETURN

COMMENTS: BOTH PUMPS HAVE DP SWITCH.

BLDG 914 CNW PUMP 1

SERVES CHILLER 1

MOTOR NAMEPLATE:	230/460V, 39/19AMP, 3PH, 60Hz, 15HP, 1765RPM
MOTOR TYPE:	US ELECTRIC ID #933/5085188R014F
FRAME GROUTED?	YES
PUMP TYPE:	AMW GPM: 950 TDH-FT: 31 MODEL #6L3 SERIAL #129196

PRESSURE TAPS ON: SUPPLY, RETURN

BLDG 914 COOLING TOWER FOR CHILLER 1

MANUFACTURER:	MARLEY MODEL #221-122 SERIES 220 SERIAL #3-1385-89
NO. OF FANS:	2 460V, 15/5AMP, 3PH, 60Hz 10/2.5HP (2 SPEED)
YEAR INSTALLED:	1989 (SPREADSHEET)

BLDG 2812 CHILLER 1

TYPE: 372 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 480V, N/A LRA, 400A, 3PH, 60Hz

MANUFACTURER: CARRIER MODEL #19DG6667CP
SERIAL #754324336

REFRG TYPE: R-11

YEAR INSTALLED: N/A (SPREADSHEET)

BLDG 2812 CW PUMP 1

SERVES CHILLER 1

MOTOR
NAMEPLATE: 230/460V, 54/27AMP, 3PH, 60Hz, 20HP, 1750RPM

MOTOR TYPE: UNICLOSED MOTOR FRAME: 256T

FRAME GROUTED? NO

PUMP TYPE: PACO NO: 4011-1 TYPE: KPG HORIZONTAL
GPM: 416 TDH-FT: 95 RPM: 1750
HP: 20 SPLIT CASE DOUBLE SUCTION

COMMENTS: NO NAMEPLATE; ALL INFORMATION FROM MANUAL

BLDG 2812 CNW PUMP 1

SERVES CHILLER 1

MOTOR NAMEPLATE:	230/460V, 63/31.5AMP, 3PH, 60Hz, 25HP, 1760RPM
MOTOR TYPE:	UNICLOSED FRAME: 284T TYPE: R
FRAME GROUTED:	NO
PUMP TYPE:	PACO NO:4011-7 TYPE: KPG HORIZONTAL SPLIT CASE GPM: 1092 TDH-FT: 55

BLDG 2812 COOLING TOWER FOR CHILLER 1

MANUFACTURER:	MARLEY	MODEL #8609 (SPREADSHEET) SERIAL #4-884-75
NO. OF FANS:	1	
YEAR INSTALLED:	N/A (SPREADSHEET)	

BLDG 3442 CHILLER 1

TYPE: 600 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 460V, 3PH, 60Hz

MANUFACTURER: TRANE
MODEL #CVHE-063F-AQ-2PC2453CE1C11DEEC00-0000004SZ1A0CPL4533-6519-01
SERIAL #L88K04614

REFRG TYPE: R-11

YEAR INSTALLED: 1988

BLDG 3442 CHILLER 2

TYPE: 600 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 460V, 3PH, 60Hz

MANUFACTURER: TRANE MODEL#CVHE-063F-AQ-2PC2453CEZC11DEGC00-0000004SZ1A0CPL4533-6518-01
SERIAL #L88K04613

REFRG TYPE: R-11

YEAR INSTALLED: 1988

BLDG 3442 CW PUMPS 1 & 2

SERVES CHILLERS 1 & 2

MOTOR
NAMEPLATE: 230/460V, 146/73AMP, 3PH, 60Hz, 60HP, 1774RPM

MOTOR TYPE: US ELECTRIC TYPE: RODP FRAME: 364TS

FRAME GROUTED? YES

PUMP TYPE: N/A

BLDG 3442 CNW PUMP 1

SERVES CHILLERS 1 & 2

MOTOR
NAMEPLATE: 230/460V, 104/52AMP, 3PH, 60Hz, 40HP, 1755RPM

MOTOR TYPE: GENERAL ELECTRIC MODEL #5K6237XM501G
SERIAL #KXJ1003265

FRAME GROUTED? YES

PUMP TYPE: VERTI LINE #V85-70737 TYPE: 12FHH
GPM: 1975 TDH-FT: 50 RPM 1760

COMMENTS: NO PRESSURE TAPS ON SUPPLY OR RETURN

BLDG 3442 CNW PUMP 2

SERVES CHILLERS 1 & 2

MOTOR
NAMEPLATE: 230/460V, 100/50AMP, 3PH, 60Hz, 40HP, 1760RPM

MOTOR TYPE: GENERAL ELECTRIC
MODEL #5K6247XH4A

FRAME GROUTED? YES

PUMP TYPE: VERTI LINE GPM: 1975 TDH-FT: 50 RPM: 1760

COMMENTS: NO PRESSURE TAPS ON SUPPLY OR RETURN

BLDG 3442 TWO COOLING TOWERS FOR CHILLERS 1 & 2

MANUFACTURER: MARLEY MODEL #MRP4
SERIAL #8609-4-2166-74B

NO. OF FANS: 4 15HP

YEAR INSTALLED: N/A

COMMENTS: WATER LEVEL IS LOW IN LOWER BASINS
DIRECT DRIVE FANS
WATER LEVELS IN UPPER BASINS NOT EQUAL

BLDG 4701 CHILLERS 1 & 2

TYPE: 305 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 460V, 378A, 3PH, 60Hz

MANUFACTURER: CARRIER MODEL #19DG6158CN
SERIAL #730719401 and #731019729

YEAR INSTALLED: 1962

BLDG 4701 CW PUMP 1 (NORTH)

SERVES CHILLERS 1 & 2

MOTOR
NAMEPLATE: 440V, 60.7AMP, 3PH, 60Hz, 50HP, 1775RPM

MOTOR TYPE: MARATHON MODEL #IC365UTSC36AC
FRAME: 365U

FRAME GROUTED? YES

PUMP TYPE: PACO GPM: 1320 TDH-FT: 100
MODEL #5BB-KPGM SERIAL #1AA19029A
IMP. DIA: 12"

COMMENTS: SOUTH PUMP DISCONNECTED (NEW MOTOR)

BLDG 4701 CNW PUMPS 1 & 2

SERVES CHILLERS 1 & 2

MOTOR NAMEPLATE:	220/440V, 76/38A, 3PH, 60Hz, 30HP, 1770 RPM
MOTOR TYPE:	MARATHON MODEL #ID326UTDR26CCW TYPE: TDR-BE FRAME: 326U
FRAME GROUTED?	YES
PUMP TYPE:	PACO GPM: 1650 TDH-FT: 52 MODEL #8AW-KPGM SERIAL #1AA19028-A
COMMENTS:	CNW PUMP 2 IS "OFF"

BLDG 4701 TWO COOLING TOWERS FOR CHILLERS 1 & 2

MANUFACTURER:	GOODFELLOW MODEL #PVMA SERIAL #305-J399-1-79 & 305-J399-79
NO. OF FANS:	1 EACH 440V, 24.6A, 3PH, 60Hz, 20 HP
YEAR INSTALLED:	N/A
COMMENTS:	SOUTH TOWER FAN NOT RUNNING - COULD BE CYCLING. WATER IS GOING OVER TOWER THERE IS WATER IN SUMP BASINS COOLING TOWERS FREEZE UP IN WINTER NO BYPASS LOOP ON CONDENSER WATER

BLDG 4701 COOLING TOWER FOR CHILLERS 1 & 2

MANUFACTURER:	MARLEY DOUBLEFLOW MODEL #351-4-772-73 SERIAL #4-772-73
NO. OF FANS:	2 440V, 19.2AMP, 3PH, 60Hz, 15HP
YEAR INSTALLED:	N/A
COMMENTS:	SHAFT DRIVE & GEAR BOX - STEAM TRACER LINE TO COOLING TOWER DOES NOT WORK - INSULATION ON CNW PIPES IN POOR CONDITION

BLDG 5676 CHILLER 1

TYPE: 170 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 460V, 211FLA, 3PH, 60HZ

MANUFACTURER: CARRIER MODEL #19DG5132CB
SERIAL #73 42 20665
COMPRESSOR MODEL #19DH2132CB
SERIAL #28179

REFRG TYPE: R-11

YEAR INSTALLED 1967

COMMENTS: NO BRUSHES OR BRUSH VALVES ON CONDENSER

BLDG 5676 CW PUMP 1 (TOP)

SERVES CHILLER 1

MOTOR NAMEPLATE: 230/460, 27/13.5A, 3PH, 60Hz, 10HP, 1730RPM

MOTOR TYPE: US ELECTRIC ID #F-9242B-07-210

FRAME GROUTED? NO

PUMP TYPE: PACO CAT #1-25121-733201A01-2
GPM: 270 TDH-FT: 90

COMMENTS: PRESSURE TAPS ON SUPPLY AND RETURN
PUMPS MOUNTED ON RACKS
BOTH CW PUMPS LOOK THE SAME AND RUN

BLDG 5676 CNW PUMP 1

SERVES CHILLER 1

MOTOR NAMEPLATE:	230/460V, 22/11A, 3PH, 60Hz, 7.5HP, 1165RPM
MOTOR TYPE:	GENERAL ELECTRIC MODEL #5K 254AL 305
FRAME GROUTED?	YES
PUMP TYPE:	ALLIS CHALMERS SIZE & TYPE: 2000 MODEL: 150 SERIAL #801-33958-1-1 GPM: 525 TDH-FT: 30 DIM: 6X6X9 IMP.DIA: 8.9
COMMENTS:	MOTOR LOOKS NEW

BLDG 5676 COOLING TOWER FOR CHILLER 1

MANUFACTURER:	MARLEY MODEL: SUPER AQUATOWER SERIAL 471754-961-79B
NO. OF FANS:	1 460V, 10.5A, 3PH, 60Hz, 7.5HP
FAN MOTOR:	DAYTON MODEL: 3N660A BELT SIZE: ZGB8162 RPM: 1740 NEMA EFF: 87.5% PF: 79%
YEAR INSTALLED:	1986
COMMENTS:	BELT DRIVE EXTERNAL MOTOR

BLDG 5678 CHILLER 1

TYPE: 190 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 460V, 195A, 3PH, 60Hz

MANUFACTURER: TRANE
MODEL #CVHE-020F-AC-2EB2502CAZA12CA1A000-0000051A1A
SERIAL #L82JO6486

REFRG TYPE: R-11

YEAR INSTALLED: 1985

COMMENTS: CHILLER SURGES BADLY WHEN APPROACHING PEAK CURRENT WHILE LOADING

BLDG 5678 CW PUMP 1

SERVES CHILLER 1

MOTOR
NAMEPLATE: 230/460V, 50/25AMP, 3PH, 60Hz, 20 HP, 1755RMP

MOTOR TYPE: STERLING M #B0204FFF283

PUMP TYPE: PACO GPM: 546 TDH-FT: 82
MODEL #1BLH74 SERIAL #FID3402

PRESSURE TAPS ON: SUPPLY, RETURN

COMMENTS: CW PUMP IS LEAKING VERY BADLY AROUND SEALS.

BLDG 5678 CNW PUMP 1

SERVES CHILLER 1

MOTOR
NAMEPLATE: 230/460V, 22/11AMP, 3PH, 60Hz, 7.5HP, 1165RPM

PRESSURE TAPS ON: SUPPLY, RETURN

COMMENTS: NO NAMEPLATE INFO WAS TAKEN

BLDG 5678 COOLING TOWER FOR CHILLER 1

MANUFACTURER: MARLEY MODEL: SUPER AQUATOWER
SERIAL #47175 4-961-79A

NO. OF FANS: 1

YEAR INSTALLED: 1980

COMMENTS: TOWER WATER TREATMENT SYSTEM APPARENTLY NOT WORKING

BLDG 5900 CHILLER 1

TYPE:	400 TON CENTRIFUGAL	
NAMEPLATE:	460V, 2347LRA, 476A, 3PH, 60Hz	
MANUFACTURER:	CARRIER,	MODEL #19DG6968CQ SERIAL #77 18 26211
REFRG TYPE:	R-11	
YEAR INSTALLED:	1980 (SPREADSHEET)	
COMMENTS:	BOTH CWS & CWR NEED INSULATION AT POINTS OF ENTRY INTO CHILLER	

BLDG 5900 CHILLER 2

TYPE:	400 TON CENTRIFUGAL	
COMPRESSOR: NAMEPLATE	460V, 783LRA, 438A, 3PH, 60Hz, N/A HP	
MANUFACTURER:	WESTINGHOUSE	MODEL #TC 418 B SERIAL #DY95
REFRG TYPE:	R-12	
YEAR INSTALLED:	1982 (SPREADSHEET)	
COMMENTS:	COOLING TOWER UNDERSIZED COOLING TOWER LOOKS TO BE OPERATING FINE - GETTING TO HIGH CNW TEMPERATURES	

BLDG 5900 CHILLER 3

TYPE:	400 TON CENTRIFUGAL	
COMPRESSOR NAMEPLATE:	480V, 692LRA, 346A, 3PH, 60Hz	
MANUFACTURER:	CARRIER	MODEL #19DK7687CN SERIAL #85 05 365 14
YEAR INSTALLED:	1988 (SPREADSHEET)	
COMMENTS:	CHILLED WATER PUMP DISCHARGE VALVE RATTLES.	

BLDG 5900 CHILLER 4

TYPE:	450 TON CENTRIFUGAL	
COMPRESSOR NAMEPLATE:	480V, 816LRA, 501A, 3PH 60Hz	
MANUFACTURER:	McQUAY	MODEL #PE HO 76 SERIAL #5 RFO 300 700
REFRG TYPE:	R-500	
YEAR INSTALLED:	1989 (SPREADSHEET)	
COMMENTS:	CHILLER METERS NOT FUNCTIONING PROPERLY UNIT NOT RUNNING AT TIME OF SURVEY	

BLDG 5900 CHILLER 5

TYPE:	400 TON CENTRIFUGAL		
COMPRESSOR NAMEPLATE:	460V, 1044LRA, 399A, 3PH 60Hz,		
MANUFACTURER:	CARRIER	MODEL #19DK78404CQ	SERIAL #87 15 39461
YEAR INSTALLED:	1988 (SPREADSHEET)		
COMMENTS:	HAS EMCS INPUT TERMINALS READY		

BLDG 5900 CW PUMP 1

SERVES CHILLER 1

MOTOR NAMEPLATE:	230/460V, 125/62.5AMP, 3PH, 60Hz, 50HP, 1770RPM
MOTOR TYPE:	LINCOLN FRAME: 326T
FRAME GROUTED?	NO
PUMP TYPE:	PEERLESS SIZE: 3AD 15 1/2 TYPE:5300 RPM: 1750 GPM: 700 TDH-FT: 190 SERIAL #384899

BLDG 5900 CW PUMP 2

SERVES CHILLER 2

MOTOR NAMEPLATE:	230/460V, 138/69AMP, 3PH, 60Hz, 60 HP, 3535RPM
MOTOR TYPE:	MARATHON MODEL #326TSTDR 700ICE W
FRAME GROUTED?	YES
PUMP TYPE:	AURORA #60-00072-1 TYPE: 411 BF GPM: 700 TDH-FT: 190 RPM:3500 SIZE 3X4X10B
COMMENTS:	PRESSURE & TEMP. TAPS ON SUPPLY & RETURN

BLDG 5900 CW PUMP 3

SERVES CHILLER 3

MOTOR NAMEPLATE:	230/460V, 151/75AMP, 3PH, 60Hz, 60HP, 1780RPM
FRAME GROUTED?	NO
MOTOR TYPE:	US ELECTRIC ID #R-9420-03-971
PUMP TYPE:	BELL & GOSSETT ID #A58 GMP: 700 TDH-FT: 190 RPM: 1750 HP:60 MODEL #VSCS-S13-1/2 BFLHR SERIAL #1261 301 DIM:4X5X14 3/4

BLDG 5900 CW PUMP 4

SERVES CHILLER 4

MOTOR NAMEPLATE	230/460V, 186/93AMP, 3PH, 60Hz, 75HP, 1775RPM
MOTOR TYPE:	MARATHON ELECTRIC M #SJ 365TSTDS 7026JPW
FRAME GROUTED?	NO

PUMP INACCESSIBLE BECAUSE OF INSULATION

BLDG 5900 CW PUMP 5

SERVES CHILLER 5

MOTOR NAMEPLATE:	230/460V, 154/77AMP, 3PH, 60Hz, 60HP, 1775 RPM			
MOTOR TYPE:	MARATHON	M #364TSTDS7026JP W TYPE: TDS		
FRAME GROUTED?	NO			
PUMP TYPE:	BELL & GOSSETT	GPM: 700	TDH-FT: 293	RPM: 1750
	HP: 60	MODEL #VSCS 13 5/8-BF RHR		
	DIM: 4X5X14 3/4	SERIAL #1358472		

BLDG 5900 CNW PUMP 1

SERVES CHILLER 1

MOTOR NAMEPLATE:	230/460V, 64/32AMP, 3PH, 60Hz, 25HP, 1750RPM
MOTOR TYPE:	CENTURY PART TYPE: 6-320819-01, TYPE: SC
FRAME GROUTED?	NO
PUMP TYPE:	PEERLESS SIZE: 6AD-10 TYPE: 5300 GPM: 1200 TDH-FT: 61 RPM: 1750 SERIAL 386072

BLDG 5900 CNW PUMP 2

SERVES CHILLER 2

MOTOR NAMEPLATE:	230/460V, 79.6/39.8AMP, 3PH, 60Hz, 30HP, 1755RPM
MOTOR TYPE:	US ELECTRIC MODEL #R-6317-04-667 N
FRAME GROUTED?	YES
PUMP TYPE:	AURORA NO. #30-00071-1 GMP: 1200 TDH-FT: 75 RPM:1750 DIM: 5X6X11
COMMENTS:	PRESSURE & TEMP. TAPS ON SUPPLY & RETURN

BLDG 5900 CNW PUMP 3

SERVES CHILER 3

MOTOR NAMEPLATE:	230/460V, 76.2/38AMP,3PH, 60Hz, 30HP, 1760RPM
MOTOR TYPE:	US ELECTRIC ID #F-6317-07-073
FRAME GROUTED?	NO
PUMP TYPE:	BELL & GOSSETT ID #A58 GPM: 1200 TDH-FT: 75 RPM: 1750 HP: 30 MODEL #VSCS-59 3/8-BF RHR SERIAL #257911 DIM: 6X8X9 3/4H

BLDG 5900 CNW PUMP 4

SERVES CHILLER 4

MOTOR NAMEPLATE:	230/460V, 104/52AMP, 3PH, 60Hz, 1765RPM		
MOTOR TYPE:	MARATHON	MODEL #TA 324TT DR 7026HNW	
FRAME GROUTED?	NO		
PUMP TYPE:	BELL & GOSSETT	M #VSCS 9 5/8 BFR HR	
	GPM: 1350	TDH-FT: 75	RPM: 1750
	HP: 40	DIM: 6X8X93/4-H	

BLDG 5900 CNW PUMP 5

SERVES CHILLER 5

MOTOR NAMEPLATE:	230/460V, 76.2/38AMP, 3PH, 60Hz, 30HP, 1760RPM			
MOTOR TYPE:	US ELECTRIC	ID #6317/NION227RO51F		
FRAME GROUTED?	NO			
PUMP TYPE:	BELL & GOSSETT	ID #E78	GPM: 1200	TDH-FT:75
	RPM: 1750	HP: 30		
	MODEL #VSCS 9 3/8-BF RHR		SERIAL #1391148	

BLDG 5900 COOLING TOWER FOR CHILLER 1

MANUFACTURER:	GOODFELLOW	MODEL #PBM 400 SERIAL #760 416
NO. OF FANS:	1	
YEAR INSTALLED:	1980 (SPREADSHEET)	
COMMENTS:	COOLING TOWER HAS NO VISIBLE NAMEPLATE, SO ALL INFORMATION WAS TAKEN FROM CENTRAL PLANT SPREADSHEET. HAS SHALLOW BASIN SUMP. COULD BE UNDERSIZED.	

BLDG 5900 COOLING TOWER FOR CHILLER 2

MANUFACTURER:	GOODFELLOW	MODEL #SDF-4250 SERIAL #J-314-80
NO. OF FANS:	1	
YEAR INSTALLED:	1982 (SPREADSHEET)	
COMMENTS:	FAN IS 2 SPEED SWITCH BROKEN, RUNNING IN "HIGH") TOWER UNDERSIZED 3 WAY VALVE ON TOWER 2 THERMOSTATS (2 SPEED FAN, AND 3 WAY VALVE) BELT DRIVE TOWER HAS SHALLOW BASIN SUMP	

BLDG 5900 COOLING TOWER FOR CHILLER 3

MANUFACTURER:	BALTIMORE AIRCOIL CO. MODEL #24220 SERIAL #84-5818D (SPREADSHEET)
NO. OF FANS:	1
YEAR INSTALLED:	1988 (SPREADSHEET)
COMMENTS:	BELT DRIVE TOWER 2 SPEED FAN MOTOR 3 WAY VALVE ON TOWER HAS SHALLOW BASIN SUMP TOWER COULD BE UNDERSIZED

BLDG 5900 COOLING TOWER FOR CHILLER 4

MANUFACTURER:	MARLEY	MODEL #222-521 SERIAL #3-894-87
NO. OF FANS:	1	460V, 30/14A, 3PH, 60Hz, 25/6.2HP
YEAR INSTALLED:	1989 (SPREADSHEET)	
COMMENTS:	2 SPEED FAN UNIT NOT RUNNING PRESENTLY 3 WAY VALVE ON TOWER 2 THERMOSTATS (2 SPEED FAN & VALVE)	

BLDG 5900 COOLING TOWER FOR CHILLER 5

MANUFACTURER: MARLEY MODEL #222-511
SERIAL #3-484-88

NO. OF FANS: 1 460V, 24/8AMPS, 3PH, 60Hz, 20/5HP

YEAR INSTALLED: 1988 (SPREADSHEET)

COMMENTS:
2 SPEED FAN
3 WAY VALVE ON TOWER
2 THERMOSTATS (2 SPEED FAN & VALVE)

BLDG 6003 CHILLER 1

TYPE: 400 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 460V, 876LRA, 555A, 3PH, 60Hz

MANUFACTURER: TRANE CENTRAVAC SERIAL #L81B21810
MODEL #CV11A-044F-HH-09LH1AYAH1SA1A51600

REFRG TYPE: R-11

YEAR INSTALLED: 1984 (SPREADSHEET)

COMMENTS: SURGED TOO DRASTICALLY TO CHECK

BLDG 6003 CHILLER 2

TYPE: 450 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 480V, N/A LRA, 400A, 3PH, 60Hz

MANUFACTURER: TRANE CENTRAVAC SERIAL #L86D37156
MODEL #CVHE-0456-AH-2KB2371CE3C13DEFC000-00000-21J00

REFRG TYPE: R-11

YEAR INSTALLED: 1986 (SPREADSHEET)

BLDG 6003 CHILLER 3

TYPE: 450 TON CENTRIFUGAL

COMPRESSOR
NAMEPLATE: 480V, N/A LRA, 400A, 3PH, 60Hz

MANUFACTURER: TRANE CENTRAVAC SERIAL #L86D37155
MODEL #CVHE-045G-AH-ZKB2378CE3C13EFC-0000000021JOO

REFRG TYPE: R-11

YEAR INSTALLED: 1986 (SPREADSHEET)

COMMENTS: CONTROLS HUNT

BLDG 6003 CW PUMP 1

SERVES CHILLER #1

MOTOR
NAMEPLATE: 230/460V, 125/62.5AMP, 3PH, 60Hz, 50HP, 1770RPM

MOTOR TYPE: LINCOLN AC CODE: TV-3596 FRAME: 326 T
S #2383663

FRAME GROUTED? N/A

PUMP TYPE: N/A

BLDG 6003 CW PUMP 2

SERVES CHILLER 2

MOTOR
NAMEPLATE: 230/460V, 125/62.5AMP, 3PH, 60Hz, 50HP, 1770RPM

MOTOR TYPE: LINCOLN S #2383664 FRAME: 326T

FRAME GROUTED? N/A

BLDG 6003 CW PUMP 3

SERVES CHILLER 3

MOTOR
NAMEPLATE: 230/460V, 125/62.5AMP, 3PH, 60Hz, 50HP, 1770RPM

MOTOR TYPE: LINCOLN CODE #TV 3596 FRAME: 286T
SERIAL #3021542

FRAME GROUTED? N/A

BLDG 6003 CNW PUMP 1

SERVES CHILLER 1

MOTOR
NAMEPLATE: 230/460V, 70/37AMP, 3PH, 60Hz, 30HP, 1765RPM

MOTOR TYPE: MARATHON ELECTRIC MODEL #BE286TTDR7026CDW
FRAME: 286T
TYPE: TDR-BE

FRAME GROUTED? N/A

PUMP TYPE: N/A

BLDG 6003 CNW PUMP 2

SERVES CHILLER 2

MOTOR NAMEPLATE: 230/460V, 74/37AMP, 3PH, 60Hz, 30HP, 1770RPM

MOTOR TYPE: LINCOLN CODE: TV 3753 FRAME: 286T

FRAME GROUTED? N/A

BLDG 6003 CNW PUMP 3

SERVES CHILLER 3

MOTOR NAMEPLATE: 230/460V, 70/37AMP, 3PH, 60Hz, 30HP, 1765RPM

MOTOR TYPE: MARATHON M #BE286TTDR7026CDW
FRAME: 2865 TYPE: TDR-BE

FRAME GROUTED? N/A

PUMP TYPE: N/A

PRESSURE TAPS ON: N/A

BLDG 6003 COOLING TOWER FOR CHILLER 2 & 3

MANUFACTURER: MARLEY MODEL #8811
SERIAL #88114-313-81

NO. OF FANS: N/A

YEAR INSTALLED: 1984 (SPREADSHEET)

COMMENTS: HAS BYPASS VALVE & TEMP. CONTROL

BLDG 6003 COOLING TOWER FOR CHILLER 1

MANUFACTURER: MARLEY SERIAL #8619-4-627-73

NO. OF FANS: N/A

YEAR INSTALLED: 1984 (SPREADSHEET)

CHILLER FIELD SURVEY NOTES

JOB 3002.000 FT. SILL

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SHEET NO. ______ OF ______

CALCULATED BY JW DATE 9/13/90

CHECKED BY ______ DATE ______

~~SCALE~~ BLDG 730

CHILLER SURVEY FORM

CHILLER NO.: 1

MANUFACTURER: TRANE

MODEL:

SERIAL NO. L83H13856

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	640kW 800TON	821	821	460	460	
TEST READINGS						
1	564	747	802	469	470	
2	563	746	802			
3	562	746	801			
4	561	745	799			
5	561		804			
6	563		802			
7	565		803			
8	565		802			
9	565		802			
10	564		799			
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	632	287				

	CHILLED WATER PUMP #1		CONDENSER WATER PUMP #2 (MIDDLE)		COOLING TOWER	
	RATED	TESTED	RATED	TESTED	RATED	TESTED
VOLTAGE – PHASE A	460	475	220	199	230	197
VOLTAGE – PHASE B	460	477	220	202	230	200
AMPS – PHASE A	179	145	118	106.6	71.4	70.5
AMPS – PHASE B	179	150	118	108	71.4	71
kW		91		37.2		23
kVAR		80		5.8		9
kVA		120.9		37.6		25
POWER FACTOR (%)						93

OUTDOOR AIR TEMP. (DEG F)	85	OUTDOOR HUMIDITY (%RH)	61	
TIME OF TESTING				

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JOB 3002.000 FT. SILL
SHEET NO. ______ OF ______
CALCULATED BY JW DATE 9/13/90
CHECKED BY ______ DATE ______
~~SCALE~~ BLDG 730

CHILLER SURVEY FORM

CHILLER NO.: 1
MANUFACTURER: TRANE
MODEL:
SERIAL NO. L83H13856

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING						
TEST READINGS						
1						
2			OTHER	PAGE		
3						
4						
5						
6						
7						
8						
9						
10						
TEST READINGS	kVA	kVAR	P.FACTOR (%)			

	CHILLED WATER PUMP #2		CONDENSER WATER PUMP #3 (WEST)		COOLING TOWER	
	RATED	TESTED	RATED	TESTED	RATED	TESTED
VOLTAGE – PHASE A	460	477	200	199		
VOLTAGE – PHASE B	460	475	200	197		
AMPS – PHASE A	179	148	90	86.1		
AMPS – PHASE B	179	146	90	82.6		
kW		93		25.4		
kVAR		79		14.4		
kVA		122		29.1		
POWER FACTOR (%)						

OUTDOOR AIR TEMP. (DEG F)		OUTDOOR HUMIDITY (%RH)		
TIME OF TESTING				

JOB 3002.000 FT. SILL

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CALCULATED BY JW DATE 9/13/90

CHECKED BY ______ DATE ______

~~SCALE~~ BLDG 730

CHILLER SURVEY FORM

CHILLER NO.: 1

MANUFACTURER: TRANE

MODEL:

SERIAL NO. L83H13856

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	53	38	N/A	85	1336	2378
TEST READINGS						
1	61.1	50.2	95.4	79	1334	3010
2	61.0	50.0	95.5	78.9	1334	2983
3	61.0	50.1	95.4	78.9	1354	3010
4	61.0	50.0	95.4	79.0	1364	3024
5	61.0	50.0	95.4	79.0	1354	3024
6	60.9	49.9	95.4	78.9	1384	3038
7	60.7	49.8	95.5	78.9	1384	3038
8	60.7	49.8	95.4	78.9	1374	3024
9	60.7	49.8	95.4	78.9	1384	2997
10	60.5	49.7	95.4	78.9	1374	3024

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					
	47	38	13.5	8	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING	250	FT. HD.		FT. HD.	
TEST READINGS					
	55	195	0	19	

JOB 3002,000 FT. SILL

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CALCULATED BY JW DATE 9/13/90

CHECKED BY ______ DATE ______

~~SCALE~~ BLDG 730

CHILLER SURVEY FORM

CHILLER NO.: 3 (NORTH) MODEL:

MANUFACTURER: TRANE SERIAL NO. L80A06559

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	320TON	367	367	480	480	
TEST READINGS						
1	214	285	313	461	465	
2	215	286				
3	215	286				
4	214	286				
5	214	286				
6	214	287				
7	215	286				
8	215	286				
9	214	286				
10	214	286				
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	240	108				

	CHILLED WATER PUMP #2 (CENTER OF 3)		CONDENSER WATER PUMP#1 (EAST)		COOLING TOWER	
	RATED	TESTED	RATED	TESTED	RATED	TESTED
VOLTAGE – PHASE A		200	220	198.6		
VOLTAGE – PHASE B		198	220	202		
AMPS – PHASE A		63.5	118	101.7		
AMPS – PHASE B		62.9	118	104		
kW		20.2		35.7		
kVAR		9.1		5.8		
kVA		22.1		36.4		
POWER FACTOR (%)		91				

OUTDOOR AIR TEMP. (DEG F)	85	OUTDOOR HUMIDITY (%RH)	61	
TIME OF TESTING				

JOB 3002.000 FT. SILL

SHEET NO. ____ OF ____

CALCULATED BY JW DATE 9/13/90

CHECKED BY ____ DATE ____

~~SCALE~~ BLDG 730

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

CHILLER SURVEY FORM

CHILLER NO.: 3 (NORTH) MODEL:

MANUFACTURER: TRANE SERIAL NO. L80A06559

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING						
TEST READINGS						
1	57.6	43.0	84.9	75.5	471	990
2	57.6	43.1	84.8	75.4	474	986
3	57.7	43.0	84.8	75.4	474	982
4	57.7	43.0	84.8	75.4	474	986
5	57.6	43.0	84.8	75.4	474	982
6	57.6	43.0	84.8	75.5	474	978
7	57.6	43.0	84.8	75.3	471	978
8	57.6	43.0	84.8	75.3	471	986
9	57.6	42.9	84.8	75.3	471	986
10	57.7	43.0	84.8	75.3	471	978

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					
	54	48	21	13	

	#2 (CENTER) CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	#1 (EAST) CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING		FT. HD.		FT. HD.	
TEST READINGS					
	19	60.5	-1	20	

JOB 3002.000 FT. SILL

SHEET NO. ____ OF ____

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

CALCULATED BY JW DATE 9/14/90

CHECKED BY ____ DATE ____

~~SCALE~~ BLDG 914

CHILLER SURVEY FORM

CHILLER NO.: 1
MANUFACTURER: TRANE

MODEL:
SERIAL NO. L89J03103

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	58	45			800	950
TEST READINGS						
1	50.8	46.5	94.0	50.8	712	1156
2	50.9	46.5	94.0	50.9	723	1248
3	50.9	46.4	94.0	50.9	727	1217
4	50.8	46.4	93.9	50.8	734	1223
5	50.8	46.4	93.9	50.8	727	1180
6	50.9	46.4	93.9	50.9	727	1174
7	50.7	46.5	93.8	50.7	727	1052
8	50.9	46.5	93.8	50.9	723	984
9	50.8	46.4	93.8	50.8	730	978
10	50.7	46.4	93.8	50.7	730	978

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					
	55	45	16	10	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING	70 FT. HD.		41 FT. HD.		
TEST READINGS					
	16.5	60	2.6	19	

JOB 3002.000 FT. SILL

SHEET NO. ______ OF ______

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

CALCULATED BY JW DATE 9/14/90

CHECKED BY ______ DATE ______

~~SCALE~~ BLDG 914

CHILLER SURVEY FORM

CHILLER NO.: 1

MANUFACTURER: TRANE

MODEL:

SERIAL NO. L89J03103

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	241kW 400TON	339	339	460	460	
TEST READINGS						
1	174	234	245	473	473	
2	163					
3	163					
4	162					
5	163					
6	162					
7	161					
8	160					
9	161					
10	161					
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	193	102				

	CHILLED WATER PUMP RATED	CHILLED WATER PUMP TESTED	CONDENSER WATER PUMP RATED	CONDENSER WATER PUMP TESTED	COOLING TOWER FAN #2 RATED	COOLING TOWER FAN #2 TESTED *
VOLTAGE – PHASE A	460	472	460	476	460	477
VOLTAGE – PHASE B	460	472	460	475	460	476
AMPS – PHASE A	48	41.3	19	14.6	15	12.9
AMPS – PHASE B	48	41.3	19	14.2	15	11.8
kW		29.8		9.4		8.6
kVAR		15.7		7.7		5.9
kVA				12.2		10.5
POWER FACTOR (%)				77.4		82.3

* HIGH SPEED

OUTDOOR AIR TEMP. (DEG F)	99	OUTDOOR HUMIDITY (%RH)	28	
TIME OF TESTING	15:05			

NOTE: CURRENT LIMIT SET AT 90%.

JOB 3002.000 FT. SILL

E M C ENGINEERS, INC.

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SHEET NO. ____ OF ____

CALCULATED BY JW DATE 9/17/90

CHECKED BY ____ DATE ____

~~SCALE~~ BLDG 2812

CHILLER SURVEY FORM

CHILLER NO.: 1
MANUFACTURER: CARRIER

MODEL: 19DG6667CP
SERIAL NO. 7543 24336

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	61	40	95	85	416	1092
TEST READINGS						
1	49.7	41.8	86.1	81.2	522	1337
2	49.7	41.8	86.1	81.2	542	1337
3	49.7	41.8		81.4	545	1326
4	49.6	41.8		81.3	584	1332
5	49.6	41.7		81.2	440	1342
6	49.6	41.7			496	1359
7	49.7	41.7			507	1359
8	49.7	41.7			553	1365
9	49.7	41.7			555	1354
10	49.7	41.8	86.2		562	1337

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING	ΔP = 3.5 PSI (MAX)		ΔP = 7.8 PSI (MAX)		
TEST READINGS					
	~~N/A~~	~~44.5~~	13.5	6	
	NO TAP	44.5			

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING	41 PSI OR	95 FT. HD.	24 PSI OR	55 FT. HD.	
TEST READINGS					
	41.5	79.5	-1.5	18	

JOB 3002.000 FT. SILL

SHEET NO. ____ OF ____

E M C ENGINEERS, INC.

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CALCULATED BY JW DATE 9/17/90

CHECKED BY ____ DATE ____

~~SCALE~~ BLDG 2812

CHILLER SURVEY FORM

CHILLER NO.: 1

MANUFACTURER: CARRIER

MODEL: 19DG6667CP

SERIAL NO. 754324336

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	372 TON	410	410	480	480	
TEST READINGS						
1	144.6	219	203	482	482	
2	144.3					
3	142.7					
4						
5						
6						
7						
8						
9						
10						
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	175.6	100.5	81.3			

	CHILLED WATER PUMP		CONDENSER WATER PUMP		COOLING TOWER	
	RATED	TESTED	RATED	TESTED	RATED	TESTED
VOLTAGE – PHASE A	460	484	460	482	N/A	483
VOLTAGE – PHASE B	460	482	460	484		481
AMPS – PHASE A	27	23.2	31.5	26.2		18.6
AMPS – PHASE B	27	22.8	31.5	27.6		18.6
kW		14.4		17.8		11.8
kVAR		13.0		13.6		10.4
kVA		19.4		22.4		15.6
POWER FACTOR (%)		74.2		79.5		75.1

OUTDOOR AIR TEMP. (DEG F)	82.7	OUTDOOR HUMIDITY (%RH)	68.5	
TIME OF TESTING				

JOB 3002.000, FT. SILL

SHEET NO. ______ OF ______

E M C ENGINEERS, INC.

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CALCULATED BY CEL DATE 9/11/90

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SCALE BLDG 3442

CHILLER SURVEY FORM

CHILLER NO.: 1

MANUFACTURER: TRANE

MODEL: CVHE-063F-AQ-2PC2453CEIC11DEECOD000004SZ-1AC

SERIAL NO. L88K04614

PL 4533-6519-01

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	60	45		85	1126	1975
TEST READINGS						
1	54.6	45.2	89.7	79.4	1130	1882
2	54.5	45.2			1145	1882
3	54.5	45.2			1140	1912
4	54.5	45.2			1130	1902
5	54.5	45.2			1140	1892
6	54.6	45.2			1120	1902
7	54.6	45.3			1130	1902
8	54.5	45.2			1135	1912
9	54.5	45.1			1155	1902
10	54.5	45.0			1145	1892

15 sec. INTERV[AL]

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					
	45.6	36.4	11.8	5.4	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING	140	FT. HD.	50	FT. HD.	
TEST READINGS					
	26	84	— NO	TAPS —	

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JOB 3002.000, FT. SILL

SHEET NO. ______ OF ______

CALCULATED BY CEL DATE 9/11/90

CHECKED BY ______ DATE ______

~~SCALE~~ BLDG 3442

CHILLER SURVEY FORM

CHILLER NO.: 1

MANUFACTURER: TRANE

MODEL:

SERIAL NO. L88K04614

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	360 KW @ 600T	502	502	460	460	
TEST READINGS						
1	299	403	421	480	480	15 SEC. INTERVALS
2	297					
3	298					
4	298					
5	298					
6	297					
7	298					
8	298					
9	298					
10	297					
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	343	170.9				

	CHILLED WATER PUMP		CONDENSER WATER PUMP		COOLING TOWER	
	RATED	TESTED	RATED	TESTED	RATED	TESTED
VOLTAGE – PHASE A	460	482	460	481		NOT
VOLTAGE – PHASE B	460	481	460	481	15 HP	ACCESSABLE
AMPS – PHASE A	73	63.5	52	42.1	each,	
AMPS – PHASE B	73	62.5	52	41.1	total	
kW		44		24.0	of	
kVAR		29.7		25.3	4 fans	
kVA		51.9		34.7		
POWER FACTOR (%)						

OUTDOOR AIR TEMP. (DEG F)	80	OUTDOOR HUMIDITY (%RH)	57	
TIME OF TESTING	12:10			

JOB 3002.000

SHEET NO. ______ OF ______

E M C ENGINEERS, INC.

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CALCULATED BY LEL DATE 9/11/90

CHECKED BY ______ DATE ______

~~SCALE~~ BLDG 3442

CHILLER SURVEY FORM

CHILLER NO.: 2

MANUFACTURER: TRANE

MODEL: AS CHILLER 1 Same except -6518-01

SERIAL NO. L88K04613

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	360 kw @ 600T	502	502	460	460	
TEST READINGS						
1	310	416	440	480	480	
2	311					
3	311					
4	308					
5	310					
6	311					
7	309					
8	309					
9	310					
10	310					
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	357	177				

	CHILLED WATER PUMP RATED	CHILLED WATER PUMP TESTED	CONDENSER WATER PUMP RATED	CONDENSER WATER PUMP TESTED	COOLING TOWER RATED	COOLING TOWER TESTED
VOLTAGE – PHASE A	460	482	460	482		
VOLTAGE – PHASE B	460	480	460	480	See	
AMPS – PHASE A	73	63.8	52	35.3	chiller	
AMPS – PHASE B	73	63.0	52	34.3		
kW		43.8		22.1	1	
kVAR		29.1		19.2		
kVA		52.4		29.1		
POWER FACTOR (%)						

OUTDOOR AIR TEMP. (DEG F)	88.4	OUTDOOR HUMIDITY (%RH)	37.0	
TIME OF TESTING	2:45			

JOB 3002.000 FT. SILL

SHEET NO. ______ OF ______

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~~SCALE~~ BLDG 3442

CHILLER SURVEY FORM

CHILLER NO.: 2
MANUFACTURER: TRANE

MODEL: SAME AS CHR 1
SERIAL NO. L88K04613

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	60	45		85	1126	1975
TEST READINGS						
1	55.5	45.4	85.6	78.7	1244	2182
2	55.5	45.4			1244	2091
3	55.5	45.4	86.5	79.1	1215	2079
4	55.5	45.3			1195	2103
5	55.4	45.3	86.2	78.8	1205	2151
6	55.4	45.4			1205	2247
7	55.4	45.4			1215	2282
8	55.5	45.4			1195	2318
9	55.5	45.4			1225	2306
10	55.5	45.4			1225	2294

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					
	46.7	39.6	10.5	6.4	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING	140	FT. HD.	50	FT. HD.	
TEST READINGS					
	29	83	30	84	

JOB 3002.000 FT. SILL

E M C ENGINEERS, INC.

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SHEET NO. ______ OF ______

CALCULATED BY JW DATE 9/18/91

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~~SCALE~~ BLDG 4701

CHILLER SURVEY FORM

CHILLER NO.: 1

MANUFACTURER: CARRIER

MODEL: 19DG6138CN

SERIAL NO. 73-07-19401

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	53	43	95	85	1320	1650
TEST READINGS						
1	41.9	48.2	88.0	80.2	543	785
2	42.1	47.8	87.4	79.1	530	778
3	42.0	47.8	88.2	80.2	530	778
4	42.0	47.8	88.3	80.4	548	770
5	42.0	47.9	88.3	80.4	543	770
6	42.1	47.9	87.8	80.1	522	770
7	42.0	47.8	88.0	79.8	513	763
8	41.8	47.5	88.2	80.1	529	732
9	41.5	47.3	88.1	80.3	569	748
10	42.0	47.9	88.2	80.3	526	759

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING	ΔP = 10PSI (MAX)		ΔP = 8.7PSI (MAX)		
TEST READINGS					
	~~26~~ 67.5	76	CLOGGED GAUGE	11	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING		100 FT. HD.	22.5 PSI or	52 FT. HD.	
TEST READINGS					
	42.5	75	-7	19	

JOB 3002.000 FT. SILL

SHEET NO. ______ OF ______

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SCALE BLDG 4701

CHILLER SURVEY FORM

CHILLER NO.: 1
MANUFACTURER: CARRIER
MODEL: 19DG6138CN
SERIAL NO. 73-07-19401

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	305TON	378	378	460	460	
TEST READINGS						
1	169.2	207	221	482	484	
2	169.5	205	220			
3	169.8	208	220			
4	170.5	209	220			
5	169.3	208	220			
6	169.6	206	220			
7	169.5	208	220			
8	169.3	209	220			
9	169.9	208	221			
10	170.3	208	221			
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	178	54	95.3			

	CHILLED WATER PUMP		CONDENSER WATER PUMP		COOLING TOWER WEST	
	RATED	TESTED	RATED	TESTED	RATED	TESTED
VOLTAGE – PHASE A	440	484	440	489	440	489
VOLTAGE – PHASE B	440	487	440	492	440	492
AMPS – PHASE A	60.7	50.0	38	32.0	19.2	15.8
AMPS – PHASE B	60.7	51.6	38	34.7	19.2	17.5
kW		33.1		24.8		10.5
kVAR		28.4		14.2		9.8
kVA		43.6		28.4		14.3
POWER FACTOR (%)		76.1		86.7		73.5

OUTDOOR AIR TEMP. (DEG F)	79.7	OUTDOOR HUMIDITY (%RH)	85.4	
TIME OF TESTING				

JOB 3002.000 FT. SILL

E M C ENGINEERS, INC.

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SHEET NO. ______ OF ______

CALCULATED BY J W DATE 9/18/90

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~~SCALE~~ BLDG 4701

CHILLER SURVEY FORM

CHILLER NO.: 2
MANUFACTURER: CARRIER

MODEL: 19DG6158CN
SERIAL NO. 731019729

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	305TON	378	378	460	460	
TEST READINGS						
1	113	159	159	485	488	
2	110	156	158			
3	116	153	157			
4	94	144	160			
5	94	114	115			
6	94	120	112			
7	113	151	155			
8	112	147.7	150			
9	96	112	113			
10	112	156	148			
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	97	24	97			

	CHILLED WATER PUMP		CONDENSER WATER PUMP		COOLING TOWER (EAST)	
	RATED	TESTED	RATED	TESTED	RATED	TESTED
VOLTAGE – PHASE A	440	OFF	440	OFF	460	488
VOLTAGE – PHASE B	440		440		460	485
AMPS – PHASE A	60.7		38		24.6	18.1
AMPS – PHASE B	60.7		38		24.6	18.3
kW						12.0
kVAR						9.9
kVA						15.6
POWER FACTOR (%)						77.0

OUTDOOR AIR TEMP. (DEG F)	84.6	OUTDOOR HUMIDITY (%RH)	69.3	
TIME OF TESTING				

NOTE: THIS CHILLER LOADS & UNLOADS EVERY 20 SEC.

JOB 3002.000 FT. SILL

E M C ENGINEERS, INC.

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SHEET NO. ______ OF ______

CALCULATED BY JW DATE 9/18/90

CHECKED BY ______ DATE ______

~~SCALE~~ BLDG 4701

CHILLER SURVEY FORM

CHILLER NO.: 2

MANUFACTURER: CARRIER

MODEL: 19DG6158CN

SERIAL NO. 7310 19729

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	53	43	95	85	1320	1650
TEST READINGS						
1	48.6	43.3	86.3	80.8	660	875
2	48.4	43.6	86.8	80.8	709	886
3	48.5	43.8	86.8	80.6	697	897
4	48.4	43.6	86.0	80.7	691	908
5	48.5	42.9	85.9	80.7	666	886
6	48.3	43.2	86.8	80.8	660	880
7	48.4	43.5	86.8	80.8	685	891
8	48.5	43.8	86.5	80.9	727	891
9	48.5	43.6	86.1	80.9	727	897
10	48.4	43.2	86.7	80.8	678	902

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING	$\Delta P = 10$ PSI (MAX)		$\Delta P = 8.7$ PSI (MAX)		
TEST READINGS					
	67.0	76.5	GAUGE CLOGGED	11	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING		~~100~~ FT. HD.		FT. HD.	
TEST READINGS					
	OFF		OFF		

JOB 3002,000 FT. SILL

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SHEET NO. ______ OF ______

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~~SCALE~~ BLDG 5676

CHILLER SURVEY FORM

CHILLER NO.: 1
MANUFACTURER: CARRIER

MODEL: 19DG5132CB
SERIAL NO. 7342 20665

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	52	44	95	85	540	525
TEST READINGS						
1	57.8	53.6	89.3	80.5	465	563
2	57.2	53.2	89.3	80.5	465	563
3	57.1	53.1	89.5	80.7	465	567
4	57.0	53.0	89.7	80.8	461	571
5	56.4	52.5	89.7	80.9	465	563
6	56.2	52.1	89.7	80.8	465	563
7	55.8	51.7	89.7	80.8	486	563
8	55.8	51.6	89.9	80.9	465	563
9	55.3	51.4	89.9	81.4	470	567
10	55.5	51.4	89.9	81.9	474	571

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING	$\Delta P = 10.8$ PSI (MAX)		$\Delta P = 6.5$ PSI (MAX)		
TEST READINGS					
	24.0	38.5	NO GAUGES OR TAPS		

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING		FT. HD.		FT. HD.	
TEST READINGS					
	22.5	57.5	0	9.6	

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~~SCALE~~ BLDG 5676

CHILLER SURVEY FORM

CHILLER NO.: 1

MANUFACTURER: CARRIER

MODEL: 19DG5132CB

SERIAL NO. 73 42 20665

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	155kW	211	211	460	460	
TEST READINGS						
1	118.4	166	165	478	478	
2	118.7					
3	118.8					
4	119.1					
5	119.0					
6	118.3					
7	118.7					
8	121.0					
9	121.9					
10	120.9					
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	139.4	72.3	85.6			

	CHILLED WATER PUMP		CONDENSER WATER PUMP		COOLING TOWER	
	RATED	TESTED	RATED	TESTED	RATED	TESTED
VOLTAGE – PHASE A	460	460	460	NOT	460	480
VOLTAGE – PHASE B	460	460	460	ACCESSIBLE	460	480
AMPS – PHASE A	13.5	13.0	11		10.5	8.6
AMPS – PHASE B	13.5	13.3	11		10.5	9.4
kW		N/A				5.6
kVAR						5.5
kVA						7.9
POWER FACTOR (%)						70.7

OUTDOOR AIR TEMP. (DEG F)	77.5	OUTDOOR HUMIDITY (%RH)	98.8 (RAINING)	
TIME OF TESTING	9:00 AM			

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~~SCALE~~ BLDG 5678

CHILLER SURVEY FORM

CHILLER NO.: ~~2~~ 1
MANUFACTURER: TRANE

MODEL:
SERIAL NO. L82J06486

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	142kW 190TON	195	195	460	460	
TEST READINGS						
1	108	150	150	479	477	
2	107					
3	104					
4	105					
5	107					
6	104					
7	106					
8	107					
9	103					
10	106					
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	124.0	69.7	83.5			

	CHILLED WATER PUMP		CONDENSER WATER PUMP		COOLING TOWER	
	RATED	TESTED	RATED	TESTED	RATED	TESTED
VOLTAGE – PHASE A	460	478	460	477	N/A	480
VOLTAGE – PHASE B	460	478	460	478		478
AMPS – PHASE A	25.1	20.5	11	10.2		8.7
AMPS – PHASE B	25.1	20.0	11	10.0		9.6
kW		13.8		6.0		5.4
kVAR		9.3		5.8		5.5
kVA		16.6		8.4		7.8
POWER FACTOR (%)		83%		71.4		71.4

OUTDOOR AIR TEMP. (DEG F)	79.1	OUTDOOR HUMIDITY (%RH)	73.6	
TIME OF TESTING				

JOB 3002.000 FT. SILL

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~~SCALE~~ BLDG 5678

CHILLER SURVEY FORM

CHILLER NO.: 1
MANUFACTURER: TRANE

MODEL:
SERIAL NO. L82J06486

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	53	45.0	85	95	546	570
TEST READINGS						
1	58.9	54.4	78.6	86.1	864	670
2	58.4	54.1	79.5	86.7	918	673
3	58.0	53.7	79.6	86.7	918	673
4	58.0	53.6	79.9	86.9	914	676
5	57.7	53.5	80.0	86.6	931	676
6	57.6	53.4	80.0	86.8	927	676
7	57.2	53.2	80.0	86.8	885	676
8	57.2	53.2	80.0	86.6	859	682
9	57.0	53.0	79.8	86.5	804	686
10	56.9	53.1	79.8	86.4	900	689
	AVG = 57.7	AVG = 53.5			AVG = 892	AVG = 677

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING	$\Delta P = 9$ PSI (MAX)		$\Delta P = 6.07$ PSI (MAX)		
TEST READINGS					
	35.5	27	12	6	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING		FT. HD.		FT. HD.	
TEST READINGS					
	14	51	0	13.5	

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~~SCALE~~ BLDG 5900

CHILLER SURVEY FORM

CHILLER NO.: 1

MANUFACTURER: CARRIER

MODEL: 19DG6968CQ

SERIAL NO. 77182 6211

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	NA	476	476	460	460	
TEST READINGS						
1	323	440	451	466	466	
2	325	440	452			
3	324	442	453			
4	325	441	452			
5	325	442	452			
6	323	441	449			
7	324	441	449			
8	324	441	451			
9	325	442	451			
10	325	443	453			
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	348	153.4	89.5			

	CHILLED WATER PUMP		CONDENSER WATER PUMP		COOLING TOWER	
	RATED	TESTED	RATED	TESTED	RATED	TESTED
VOLTAGE – PHASE A	460	473	460	473	NO	473
VOLTAGE – PHASE B	460	474	460	473		473
AMPS – PHASE A	62.5	59.8	32	26.6	NAME	27.5
AMPS – PHASE B	62.5	60	32	25.9	PLATE	27.2
kW	NA.	39.5	NA	17.6		19.2
kVAR		29.2		12.4		11.5
kVA		49.1		21.5		22.0
POWER FACTOR (%)		80.4		81.8		85.6

OUTDOOR AIR TEMP. (DEG F)	96.8	OUTDOOR HUMIDITY (%RH)	32.3	
TIME OF TESTING	14:40			

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~~SCALE~~ BLDG 5900

CHILLER SURVEY FORM

CHILLER NO.: 1
MANUFACTURER: CARRIER
MODEL: 19DG6968CQ
SERIAL NO. 7718Z6Z11

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	53.7	40	95	85	700	1200
TEST READINGS			78°F W.B.			
1	58.6	45.7	103.7	93.8	688	1588
2	58.6	45.8		94.8	699	1594
3	58.6	46.0		95.2	677	1588
4	58.9	46.1		95.8	682	1581
5	59.0	46.2		95.9	682	
6	59.1	46.3		96.5	671	
7	59.1	46.4		96.6	666	
8	59.1	46.4		96.7	671	
9	59.2	46.5		96.9	660	
10	59.3	46.4	107.3	97.0	666	

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					
	112	100	12	6	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING	190	FT. HD.	61	FT. HD.	
TEST READINGS					
	36	108	-4	22	

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~~SCALE~~ BLDG 5900

CHILLER SURVEY FORM

CHILLER NO.: 2

MANUFACTURER: WESTINGHOUSE

MODEL: TC 416B

SERIAL NO. DY95

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	315KW@400TONS	438	438	460	460	
TEST READINGS						
1	308	420	417	470	470	
2	309	421				
3	309	420				
4	310	420				
5	309	420				
6	311		418			
7	309	420	420			
8	308	422				
9	310	422				
10	310	420				
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	340	145	90.6			

	CHILLED WATER PUMP RATED	CHILLED WATER PUMP TESTED	CONDENSER WATER PUMP RATED	CONDENSER WATER PUMP TESTED	COOLING TOWER RATED	COOLING TOWER TESTED
VOLTAGE – PHASE A	460	474	460	474	No	474
VOLTAGE – PHASE B	460	473	460	474		474
AMPS – PHASE A	69	53.8	39.8	35.3	DATA	21.4
AMPS – PHASE B	69	53.4	39.8	35.9		21.6
kW		38.7		23.0		14.2
kVAR		20.9		18.3		10.1
kVA		44.2		29.4		17.6
POWER FACTOR (%)		88.0		78.2		82.3

OUTDOOR AIR TEMP. (DEG F)	83.8	OUTDOOR HUMIDITY (%RH)	44.7	
TIME OF TESTING				

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~~SCALE~~ BLDG 5900

CHILLER SURVEY FORM

CHILLER NO.: 2
MANUFACTURER: WESTINGHOUSE

MODEL: TC416B
SERIAL NO. OY95

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	53.7	40	85	95	700	1200
TEST READINGS						
1	52.5	41.7	93	100	721	1455
2	52.5	41.7			727	1449
3	52.5	41.7			727	1462
4	52.5	41.7			727	1437
5	52.5	41.7			733	1419
6	52.5	41.7			727	1431
7	52.6	41.8			727	1425
8	52.6	41.8			733	1437
9	52.5	41.7			733	1425
10	52.5	41.7	93	100	727	1437

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					
	105	101	17	NO DATA	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING	190 FT. HD.		75 FT. HD.		
TEST READINGS					
	35	107	-1	28	

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~~SCALE~~ BLDG 5900

CHILLER SURVEY FORM

CHILLER NO.: 3
MANUFACTURER: CARRIER

MODEL: 19DK7687CN
SERIAL NO. 8505365I4

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	263KW @ 372 TONS	346	346	480	480	
TEST READINGS						
1	231	330	324	470	469	
2	232	329	327			
3	231	330	325			
4	232	329	325			
5	231	329	324			
6	230	328	323			
7	230	326	323			
8	231	326	323			
9	230	327	323			
10	230	326	322	470	469	
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	~~129~~	~~265~~	87.3			
	265	129				

	CHILLED WATER PUMP RATED	CHILLED WATER PUMP TESTED	CONDENSER WATER PUMP RATED	CONDENSER WATER PUMP TESTED	COOLING TOWER RATED	COOLING TOWER TESTED
VOLTAGE – PHASE A	460	474	460	474	NO DATA	470
VOLTAGE – PHASE B	460	473	460	474		470
AMPS – PHASE A	75	62.5	38	36.3		22.9
AMPS – PHASE B	75	61.0	38	35.1		23.2
kW		41.9		24.1		14.0
kVAR		27.9		16.9		12.8
kVA		50.3		29.1		18.9
POWER FACTOR (%)		—		82.4		73.7

OUTDOOR AIR TEMP. (DEG F)	89.7	OUTDOOR HUMIDITY (%RH)	45	
TIME OF TESTING	10:10			

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~~SCALE~~ BLDG 5900

CHILLER SURVEY FORM

CHILLER NO.: 3

MANUFACTURER: CARRIER

MODEL: 19DK7687CN

SERIAL NO. 85 05 36514

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	52.8	40	95	85	700	1200
TEST READINGS						
1	54.6	45.2	93.6	86.2	736	1337
2	54.7	45.2	93.5	86.2	732	1332
3	54.5	45.3	93.5	86.1	736	1348
4	54.5	45.3	93.5	86.1	727	1351
5	54.4	45.1	93.5	86.1	719	1345
6	54.4	45.1	93.7	86.3	710	1345
7	54.4	45.0	93.7	86.3	706	1351
8	54.2	45.0	93.7	86.3	702	1345
9	54.3	45.0	93.8	86.3	710	1339
10	54.3	45.0	93.7	86.3	697	1345

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					
	101	94	19	4	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING	190	FT. HD.	75	FT. HD.	
TEST READINGS					
	34	100	-4	23.5	

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~~SCALE~~ BLDG 5900

CHILLER SURVEY FORM

CHILLER NO.: 4
MANUFACTURER: McQUAY

MODEL: PEH076
SERIAL NO. 5RF0300700

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	52.1	40	85	94	890	1350
TEST READINGS			78°F WB			
1	54.0	43.4	81.4	91.5	844	1584
2	54.0	43.4	81.4	91.6	850	1610
3	54.0	43.5	81.4	91.6	856	1627
4	54.1	43.5	81.4	91.5	856	1601
5	54.0	43.5	81.4	91.5	856	1635
6	54.0	43.5	81.4	91.5	856	1635
7	54.0	43.5	81.3	91.4	850	1652
8	53.9	43.4	81.5	91.5	862	1592
9	53.7	43.3	81.5	91.5	856	1592
10	53.8	43.4	81.5	91.5	856	1575

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					
	100	94	15	6.6	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING		FT. HD.		FT. HD.	
TEST READINGS					
	35	99	-2	32	

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SHEET NO ____ OF ____

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SCALE BLDG 5900

CHILLER SURVEY FORM

CHILLER NO.: 4

MANUFACTURER: Mc QUAY

MODEL: PE H076

SERIAL NO. 5RF0300700

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	396KW@450TON	501	501	480	480	
TEST READINGS						
1	345	481	470	465	465	
2	344	481	471			
3	344	479	472			
4	345	481	473			
5	345	478	470			
6	346	482	472			
7	346	482	472			
8	344	478	468			
9	343	479	473			
10	345	481	470			
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	386	174.2	89			

	CHILLED WATER PUMP		CONDENSER WATER PUMP		COOLING TOWER	
	RATED	TESTED	RATED	TESTED	RATED	TESTED *
VOLTAGE – PHASE A	460	463	460	464	460	468
VOLTAGE – PHASE B	460	463	460	463	460	467
AMPS – PHASE A	93	83.8	52	43.6	30/14	NOT
AMPS – PHASE B	93	80.8	52	42.4	30/14	ENOUGH
kW		54.1		26.6		SPACE TO
kVAR		38.5		23.0		TAKE
kVA		66.3		35.3		MEASUREMENT.
POWER FACTOR (%)		81.4		75.6		

* HIGH SPEED

OUTDOOR AIR TEMP. (DEG F)	85.1	OUTDOOR HUMIDITY (%RH)	46.4	
TIME OF TESTING	11:05			

JOB 9802.016, FT. SILL

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SCALE BLDG 5900

CHILLER SURVEY FORM

CHILLER NO.: 5
MANUFACTURER: CARRIER

MODEL: 190K78404CQ
SERIAL NO. 8715394b1

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	53.6	40	94	85	700	1200
TEST READINGS						
1	53.3	42.9	92.4	86.5	676	1024
2	53.3	42.9	92.4	80.4	676	1031
3	53.3	42.8	92.4	80.4	650	1031
4	53.3	42.9	92.4	80.4	642	1038
5	53.3	42.7	92.4	80.4	655	1024
6	53.3	42.7	92.4	80.4	616	1024
7	53.3	42.7	92.4	80.4	646	1024
8	53.3	42.7	92.4	80.4	603	1024
9	53.3	42.7	92.5	80.6	603	1024
10	53.3	42.7	92.6	80.6	638	1045

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					
	107	98	17	12	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING	192 FT. HD.		75 FT. HD.		
TEST READINGS					
	36	112	0	33	

JOB 9802.016, FT. SILL

SHEET NO. ______ OF ______

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

CALCULATED BY CEL DATE 9/15/90

CHECKED BY ______ DATE ______

SCALE BLDG 5900

CHILLER SURVEY FORM

CHILLER NO.: 5
MANUFACTURER: CARRIER

MODEL: 19DK 7840 4CQ
SERIAL NO. 8715 39461

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	270KW@400T	399	399	460	460	
TEST READINGS						
1	236	360	357	468	470	
2	235					
3	238					
4	238					
5	238					
6	238					
7	238					
8	238					
9	238					
10	238					
TEST READINGS	kVA	kVAR	P.FACTOR (%)			
	292	175	80			

	CHILLED WATER PUMP		CONDENSER WATER PUMP		COOLING TOWER	
	RATED	TESTED	RATED	TESTED	RATED	TESTED *
VOLTAGE – PHASE A	460	470	460	470	460	471
VOLTAGE – PHASE B	460	471	460	471	460	472
AMPS – PHASE A	77	66.5	38	31.4	24/8	24.2
AMPS – PHASE B	77	67.4	38	33.0	24/8	24.6
kW		43.6		22.0		17.1
kVAR		33.0		14.8		10.2
kVA		54.7		26.5		19.8
POWER FACTOR (%)		79.8		—		85.7

* HIGH SPEED

OUTDOOR AIR TEMP. (DEG F)	95.5	OUTDOOR HUMIDITY (%RH)	27.9	
TIME OF TESTING	~~5:00~~ 17:05			

JOB 3002,000

SHEET NO. ______ OF ______

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CALCULATED BY CEL DATE 9/12/90

CHECKED BY ______ DATE ______

~~SCALE~~ BLDG 6003

CHILLER SURVEY FORM

CHILLER NO.: 1
MANUFACTURER: TRANE

MODEL: CVIIA-044F-HH-09LH1AYA
SERIAL NO. L81B21810
H ISA 1A51600

CHILLER TEST

	kW	AMPS PHASE A	AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	NA	~445	~445	460	460	
TEST READINGS						
1						
2	— CHILLER WAS NOT OPERATIONAL —					
3						
4						
5						
6						
7						
8						
9						
10						
TEST READINGS	kVA	kVAR	P.FACTOR (%)			

	CHILLED WATER PUMP		CONDENSER WATER PUMP 3		COOLING TOWER	
	RATED	TESTED	RATED	TESTED	RATED	TESTED
VOLTAGE – PHASE A			460	466		
VOLTAGE – PHASE B	OFF		460	467		
AMPS – PHASE A			37	29		
AMPS – PHASE B	NO		37	29		
kW	DATA			17.4		
kVAR				15.3		
kVA				23.2		
POWER FACTOR (%)						

OUTDOOR AIR TEMP. (DEG F)		OUTDOOR HUMIDITY (%RH)		
TIME OF TESTING				

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JOB 3002,000

SHEET NO. ______ OF ______

CALCULATED BY CEL DATE 9/12/90

CHECKED BY ______ DATE ______

~~SCALE~~ BLDG 6003

CHILLER SURVEY FORM

CHILLER NO.: 1

MANUFACTURER: TRANE

MODEL:

SERIAL NO. L81B21810

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F)	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	58	42	95	85	645	1130
TEST READINGS						
1					685*	1208
2	Chiller not operational					1213
3						1228
4						1218
5						1223
6						1223
7						1223
8						1208
9						1213
10						1203

*GRISWALD FLOW DEVICE

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING		FT. HD.		FT. HD.	
TEST READINGS					
	OFF		3.0	37	

JOB 3002.000, FT. SILL

SHEET NO. ______ OF ______

E M C ENGINEERS, INC.

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CALCULATED BY CEL DATE 9/12/90

CHECKED BY ______ DATE ______

~~SCALE~~ BLDG 6003

CHILLER SURVEY FORM

CHILLER NO.: 2
MANUFACTURER: TRANE

MODEL: CVHE-0456-A4-2KB2371CE3C130EFC000
SERIAL NO. L86D37156

CHILLER TEST

	kW		AMPS PHASE A		AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	.60		~445		~445	460	460	
TEST READINGS	1-10	11-20	1-10	11-20				
1	57	57	119	117		460	467	15 second intervals on readings
2	56	57	132	118				
3	128	149	200	214				
4	145	137	208	215				
5	132	134	203	204				
6	129	132	205	204				
7	132	136	204	202				
8	136	136	203	208				
9	134	43	204	121				
10	120		200					
TEST READINGS	kVA		kVAR		P.FACTOR (%)			
Kw = 120	147		80					

CHILLER SURGE

	CHILLED WATER PUMP 2		CONDENSER WATER PUMP 2		COOLING TOWER	
	RATED	TESTED	RATED	TESTED	RATED	TESTED
VOLTAGE – PHASE A	460	470	460	462	N	A
VOLTAGE – PHASE B	460	470	460	462		
AMPS – PHASE A	62.5	43.0	37	30.7		
AMPS – PHASE B	62.5	45.8	37	31.9		
kW		26.6		19		
kVAR		23.1		15.8		
kVA		35.3		24.7		
POWER FACTOR (%)						

OUTDOOR AIR TEMP. (DEG F)	73	OUTDOOR HUMIDITY (%RH)	87	RAINING
TIME OF TESTING				

JOB 3002.000, FT. SILL

SHEET NO. ______ OF ______

E M C ENGINEERS, INC.

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CALCULATED BY CEL DATE 9/12/90

CHECKED BY ______ DATE ______

~~SCALE~~ BLDG 6003

CHILLER SURVEY FORM

CHILLER NO.: 2
MANUFACTURER: TRANE

MODEL:
SERIAL NO. L86D37156

	CHILLED WATER RETURN (DEG F)		CHILLED WATER SUPPLY (DEG F)		CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
	CHILLER SURGE							
DESIGN RATING	58		42		95	85	540	1130
TEST READINGS	1-10	11-20	1-10	11-20				
1	56.6	56.6	47.0	45.6	84	82	540*	1096
2			50.2	47.7				1110
3			51.9	48.9				1106
4			52.2	51.5				1106
5			50.4	51.4				1110
6			47.8	48.3				1101
7			46.0	46.7				1091
8			45.6	45.8				1101
9			45.4	45.7				1110
10			45.2	45.6				1125

* NO GOOD METERING LOCATIONS, CONSTANT FLOW DEVICE (GRISWALD) SET @ 540 GPM

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					
	40	32	19.2	10.5	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING		FT. HD.		FT. HD.	
TEST READINGS					
	6	70.5	NO READING FITTING CLOGGED	23	

JOB 3002.000, FT. SILL

SHEET NO. ______ OF ______

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~~SCALE~~ BLDG 6003

CHILLER SURVEY FORM

CHILLER NO.: 3

MANUFACTURER: TRANE

MODEL:

SERIAL NO. L86D37155

	CHILLED WATER RETURN (DEG F)	CHILLED WATER SUPPLY (DEG F) 1ST	CHILLED WATER SUPPLY (DEG F) 2ND	CONDENSER WATER RETURN (DEG F)	CONDENSER WATER SUPPLY (DEG F)	CHILLED WATER FLOW (GPM)	CONDENSER WATER FLOW (GPM)
DESIGN RATING	58	42		95	85	540	1130
TEST READINGS		1ST	2ND				
1	57	45.1	44.9	85	80	540*	1348
2		45.0	44.9				1376
3		44.9	45.0				1449
4		47.6	49.0				1486
5		50.5	51.5				1468
6		52.4	52.7				1404
7		52.8	52.9				1394
8		50.8	50.4				1385
9		47.6	47.1				1376
10		45.7	45.5				1356

15 sec. INTERV

SURGING

* NO GOOD METER SPOT. HAS FLOW DEVICE (GRISWALD) SET @ 540 GPM.

	EVAPORATOR PRESSURE RETURN (PSIG)	EVAPORATOR PRESSURE SUPPLY (PSIG)	CONDENSER PRESSURE RETURN (PSIG)	CONDENSER PRESSURE SUPPLY (PSIG)	
DESIGN RATING					
TEST READINGS					
	34.4	31.7	10.5	18.5	

	CHW PUMP PRESSURE IN (PSIG)	CHW PUMP PRESSURE OUT (PSIG)	CNW PUMP PRESSURE IN (PSIG)	CNW PUMP PRESSURE OUT (PSIG)	
DESIGN RATING		FT. HD.		FT. HD.	
TEST READINGS					
	15.0	72.0	-13 SUCTION	22	

JOB 3002,000, FT. SILL

SHEET NO. ______ OF ______

CALCULATED BY CEL DATE 9/12/90

CHECKED BY ______ DATE ______

~~SCALE~~ BLDG 6003

E M C ENGINEERS, INC.

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CHILLER SURVEY FORM

CHILLER NO.: 3

MANUFACTURER: TRANE

MODEL: CVHE-0456-AH-2KB2371CE3CBDEF

SERIAL NO. L86D37155

C0000000021J00

CHILLER TEST

	kW		AMPS PHASE A		AMPS PHASE B	VOLTAGE PHASE A	VOLTAGE PHASE B	
DESIGN RATING	.60		~445		~445	460	460	
TEST READINGS	1-10	11-20	1-10	11-20				
1	121	127	196	193		465	465	
2	124	121	196	192				
3	120	112	183	184				
4	115	108	187	180				
5	92	72	97	160				
6	54	43	114	120				
7	57		122					
8	64		120					
9	125		190					
10	122		205					

TEST READINGS	kVA	kVAR	P.FACTOR (%)			
124	140	80				

	CHILLED WATER PUMP RATED	CHILLED WATER PUMP TESTED	CONDENSER WATER PUMP RATED	CONDENSER WATER PUMP TESTED	COOLING TOWER RATED	COOLING TOWER TESTED
VOLTAGE – PHASE A	460	466	460	465	460	465
VOLTAGE – PHASE B	460	465	460	466	460	456
AMPS – PHASE A	62.5	45.0	37	33.6	63	54.7
AMPS – PHASE B	62.5	47.6	37	28.0	63	57.2
kW		28		19.0		36.3
kVAR		22.5		16.5		25.5
kVA		36.4		25.1		44.3
POWER FACTOR (%)		—		—		

OUTDOOR AIR TEMP. (DEG F)	73	OUTDOOR HUMIDITY (%RH)	87	RAINING
TIME OF TESTING				

APPENDIX F

FIELD SURVEY NOTES

BOILER-RELATED EQUIPMENT

BOILER FIELD SURVEY NOTES

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JOB 3002.000 Ft. Sill Central Plant
SHEET NO. ______ OF ______
CALCULATED BY KC DATE 2/9/91
CHECKED BY ______ DATE ______
SCALE ______

BOILER SURVEY FORM

BOILER #1

BOILER MFG.: KEWANEE
LOCATION: 730
BOILER TYPE: STEAM [X] 11 PSI
HOT WATER [ ] ______ DEG. F SET POINT
MODEL NO. 7L286-KX
BOILER'S CAPACITY: MAX BTUH OUTPUT: 7,750,000
MAX BTUH INPUT:
BOILER FUEL: OIL [ ] #______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.:
MODEL NO.
BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]
SEASONAL SWITCH OVER: SUMMER ______ TO ______
WINTER ______ TO ______

CONTROL MFG.: PEABODY-GORDON-PIATT. GP 301
(HONEYWELL) R4141089

STACK TEST:

TEST 1

OAT = 62°F
OARH = 38% RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2	*	*	*	*
TEMP (F)				
CO				
% EFF				

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

BOILER #1, 2, 3 ARE FOR WINTER USE
BOILER #4 IS FOR SUMMER USE.

* CANNOT TEST - SOOTED INDICATED INCOMPLETE COMBUSTION
HAS HAD PAST TROUBLES.

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JOB 3002.000 Ft. Sill Central Plant
SHEET NO. ________ OF ________
CALCULATED BY KC DATE 2/9/91
CHECKED BY ________ DATE ________
SCALE ________

BOILER SURVEY FORM

BOILER #2

BOILER MFG.: KEWANEE LOCATION: 730
BOILER TYPE: STEAM [X] 11 PSI HOT WATER [ ] ________ DEG. F SET POINT
MODEL NO. 7L286-KX
BOILER'S CAPACITY: MAX BTUH OUTPUT: 7,750,000
MAX BTUH INPUT: ________
BOILER FUEL: OIL [ ] # ________ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ________
MODEL NO. ________
BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]
SEASONAL SWITCH OVER: SUMMER ________ TO ________
WINTER ________ TO ________

CONTROL MFG.: PEABODY-GORDON-PIATT. GP 301
(HONEYWELL) R4141089

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2	4	3	0.4	9.7
TEMP (F)	192	295	416	421
CO	0	11.8	1.5%	0.2%
% EFF	86	84.5	82.4	81.4

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

JOB 3002.000 Ft. Sill Central Plant

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SHEET NO. ______ OF ______

CALCULATED BY KC DATE 2/9/91

CHECKED BY ______ DATE ______

SCALE ______

BOILER SURVEY FORM

BOILER #3

BOILER MFG.: KEWANEE LOCATION: 730

BOILER TYPE: STEAM [X] 11 PSI HOT WATER [ ] ______ DEG. F SET POINT

MODEL NO. 7L286-KX

BOILER'S CAPACITY: MAX BTUH OUTPUT: 7,750,000

MAX BTUH INPUT:

BOILER FUEL: OIL [ ] # ______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.:

MODEL NO.

BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: PEABODY-GORDON-PIATT. GP 301

(HONEYWELL) R4141089

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2	0.3	5.5	5.6	5.8
TEMP (F)	265	345	358	362
CO	0	0.35%.	0.2%.	0.12%.
% EFF	85.6	82.4	82	81.7

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

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JOB 3002.000 Ft. Sill Central Plant
SHEET NO. ______ OF ______
CALCULATED BY KC DATE 2/9/81
CHECKED BY ______ DATE ______
SCALE ______

BOILER SURVEY FORM

BOILER# 4

BOILER MFG.: KEWANEE
LOCATION: 730
BOILER TYPE: STEAM [X] 11 PSI HOT WATER [ ] ______ DEG. F SET POINT
MODEL NO. 7L280-KB-06
BOILER'S CAPACITY: MAX BTUH OUTPUT: 2,658,000
MAX BTUH INPUT: ______
BOILER FUEL: OIL [ ] # ______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______
MODEL NO. ______
BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]
SEASONAL SWITCH OVER: SUMMER ______ TO ______
WINTER ______ TO ______

CONTROL MFG.: PEABODY GORDON-PIATT 060794-000
091126

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2	12.5			6.3
TEMP (F)	222			371
CO	Ø			Ø
% EFF	85			81.5

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

FOR SUMMER USE.

BOILER SURVEY FORM.

BLDG. NO. 730 DATE 2/12/91

OPERATOR NAME Mike Apoka

NUMBER OF BOILER(S) 4

NUMBER OF PUMP(S) HEATING. *

	DAILY OPERATION.	NIGHT WEEKEND & HOLIDAY OPERATION.
NO. OF BOILER ON-LINE 3	ALL 3 DURING WINTER 1 DURING SUMMER	ALL 3 DURING WINTER 1 DURING SUMMER
NO. OF PUMP ON-LINE Q 2 Condensate		

BOILER SHUTDOWN BY OUTSIDE AIR TEMP X NO ___ YES ___ TEMP

MONITOR X DAILY ___ WEEKLY

COMMENTS

BLG 730 SUPPLYS BLDGS 700, 707 AND 840 WITH HOT WATER FOR HTG

* 1 CIRC. PUMP FOR 3 OUTLINE BLDGS 3 COND PUMPS FOR STEAM BOILERS

JOB 3002.000 Ft. Sill Central Plant

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SHEET NO. ______ OF ______
CALCULATED BY JW DATE 2/11/91
CHECKED BY ______ DATE ______
SCALE ______

BOILER SURVEY FORM

BOILER #1

BOILER MFG.: BURNHAM LOCATION: 914
BOILER TYPE: STEAM [X] ~~10~~ 12 PSI HOT WATER [ ] ______ DEG. F SET POINT
MODEL NO. ~~2580699~~ PP-510
BOILER'S CAPACITY: MAX BTUH OUTPUT: 1,612,000
MAX BTUH INPUT: ______
BOILER FUEL: OIL [ ] # ______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______
MODEL NO. ______
BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]
SEASONAL SWITCH OVER: SUMMER ______ TO ______
WINTER ______ TO ______

CONTROL MFG.: HONEYWELL R4795

STACK TEST:

TEST 1

OAT = 59 °F
OARH = 40 %RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2	7.3			3.9
TEMP (F)	359			387
CO	9 PPM			4 PPM
% EFF	80.9			82

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

STM BOILER SERVE DOMESTIC HW CONVERTER FOR 914.
CONTROL BY PRESSURE; CUTIN @ 2.5 PSIG AND CUTOFF @ 12 PSIG.

JOB 3002.000 Ft. Sill Central Plant

E M C ENGINEERS, INC.

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CALCULATED BY J W DATE 2/11/91

CHECKED BY ________ DATE ________

SCALE ________

BOILER SURVEY FORM

BOILER # 2

BOILER MFG.: RAYPAK LOCATION: 914

BOILER TYPE: STEAM [ ] ________ PSI HOT WATER [x] 180 DEG. F SET POINT

MODEL NO. EA 200 ITB

BOILER'S CAPACITY: MAX BTUH OUTPUT: 1,600,000

MAX BTUH INPUT: 2,000,000

BOILER FUEL: OIL [ ] # ________ GAS [x] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ________

MODEL NO. ________

BURNER TYPE FORCE AIR [ ] OPEN FLAME [x]

SEASONAL SWITCH OVER: SUMMER ________ TO ________

WINTER ________ TO ________

CONTROL MFG.: ________

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2				8.4
TEMP (F)				454
CO				14 PPM
% EFF				77.4

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS: HOT WATER / ATM

NEW CONTROLS NEEDED

E M C ENGINEERS, INC. Denver • Colorado Springs • Atlanta • West Germany	JOB 3002.000 Ft. Sill Central Plant SHEET NO. ______ OF ______ CALCULATED BY JW DATE 2/11/91 CHECKED BY ______ DATE ______ SCALE ______

BOILER SUSPECT FORM

BOILER #3

BOILER MFG.: AMERICAN STANDARD — LOCATION: 914

BOILER TYPE: STEAM [ ] ______ PSI — HOT WATER [X] ~~140~~ 160 DEG. F SET POINT

MODEL NO. G-1013

BOILER'S CAPACITY: MAX BTUH OUTPUT: 1,920,000

MAX BTUH INPUT: ~~N/A~~ 2,400,000

BOILER FUEL: OIL [ ] # ______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [ ] OPEN FLAME [X]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: HONEYWELL M904EY99DS6

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2				5.9
TEMP (F)				500
CO				26 PPM
% EFF				77.9

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS: NEW CONTROLS NEEDED
HOT WATER/ATM

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JOB 3002.000 Ft. Sill Central Plant

SHEET NO. ______ OF ______

CALCULATED BY JW DATE 2/11/91

CHECKED BY ______ DATE ______

SCALE ______

BOILER SURVEY FORM

BOILER #4

BOILER MFG.: AMERICAN STANDARD LOCATION: 914

BOILER TYPE: STEAM [ ] ______ PSI HOT WATER [x] ~~140~~ 160 DEG. F SET POINT

MODEL NO. G-1015

BOILER'S CAPACITY: MAX BTUH OUTPUT: 1,920,000

MAX BTUH INPUT: 2,400,000

BOILER FUEL: OIL [ ] # ______ GAS [x] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [ ] OPEN FLAME [x]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: HONEYWELL M904EY99D56

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2				11.1
TEMP (F)				460
CO				0
% EFF				74.4

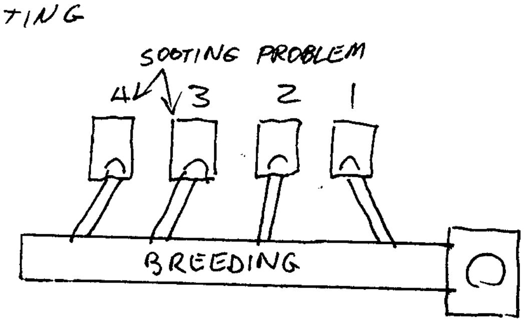
TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS: NEW CONTROLS NEEDED

HOT WATER/ATM

STACK SOOTING



BOILER SURVEY FORM.

BLDG. NO. 914 DATE 2/12/91

OPERATOR NAME Mike APOKA

NUMBER OF BOILER(S) 4

NUMBER OF PUMP(S) HEATING. 2

	DAILY OPERATION.	NIGHT WEEKEND & HOLIDAY OPERATION.
NO. OF BOILER ON-LINE 2		
NO. OF PUMP ON-LINE 2		

BOILER SHUTDOWN BY OUTSIDE AIR TEMP ___ NO X YES 65°F TEMP

MONITOR ___ DAILY X WEEKLY

COMMENTS

1 HOT WATER BOILER USED FOR HTG DURING MILD WEATER, 2 BOILERS FOR SEVERE WEATHER. 1 STEAM BOILER ALL YEAR LONG FOR MAKING HOT WATER

JOB 3002.000 Ft. Sill Central Plant

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

SHEET NO. ______ OF ______

CALCULATED BY JW DATE 2/11/91

CHECKED BY ______ DATE ______

SCALE ______

BOILER SURVEY FORM

BOILER # 1

BOILER MFG.: FEDERAL BOILER Co LOCATION: 2812

BOILER TYPE: STEAM [✓] ______ PSI HOT WATER [ ] ______ DEG. F SET POINT

MODEL NO. GS 3562 S#84/378

BOILER'S CAPACITY: MAX BTUH OUTPUT: 1,800,000

MAX BTUH INPUT: 2,250,000

BOILER FUEL: OIL [ ] # ______ GAS [✓] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [✓] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: HONEYWELL 139694B

STACK TEST:

TEST 1

OAT = 63°F

OARH = 35%RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2				8.7
TEMP (F)				380
CO				20 PPM
% EFF				79.7

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS: FOR DOMESTIC HW ONLY - SERVE 2811, MESS HALL.

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SHEET NO. ______ OF ______

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SCALE ______

BOILER SURVEY FORM

BOILER # 2

BOILER MFG.: THERMO-PAK LOCATION: 2812

BOILER TYPE: STEAM [ ] ______ PSI HOT WATER [X] 190 DEG. F SET POINT

MODEL NO. GW-5500X

BOILER'S CAPACITY: MAX BTUH OUTPUT: 3,947,000

MAX BTUH INPUT: 4,933,750

BOILER FUEL: OIL [ ] # ______ GAS [✓] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [ ] OPEN FLAME [X]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: HONEY WELL RA 890F

STACK TEST:

TEST 1

OAT = 63°F

OARH = 35% RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2	15.3			~~15.3~~ 13.3
TEMP (F)	364			429
CO	12 PPM			18 PPM
% EFF	71.7			71.5

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

JOB 3002.000 Ft. Sill Central Plant

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SHEET NO. ____ OF ____

CALCULATED BY JW DATE 2/11/91

CHECKED BY ____ DATE ____

SCALE ____

BOILER SURVEY FORM

BOILER # 3

BOILER MFG.: THERMO-PAK LOCATION: 2812

BOILER TYPE: STEAM [ ] ____ PSI HOT WATER [X] 190 DEG. F SET POINT

MODEL NO. GW-5500X

BOILER'S CAPACITY: MAX BTUH OUTPUT: 3,947,000

MAX BTUH INPUT: 4,933,750

BOILER FUEL: OIL [ ] # ____ GAS [ ] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ____

MODEL NO. ____

BURNER TYPE FORCE AIR [ ] OPEN FLAME [X]

SEASONAL SWITCH OVER: SUMMER ____ TO ____

WINTER ____ TO ____

CONTROL MFG.: HONEY WELL RA 890F

STACK TEST:

TEST 1

OAT 63°F

OARH 35% RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2	14.3			10.8
TEMP (F)	375			472
CO	15 PPM			0
% EFF	72.4			74

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

BOILER SURVEY FORM.

BLDG. NO. 2812 DATE 2-12-91

OPERATOR NAME Jerry Wilson

NUMBER OF BOILER(S) (3) 2 Hot Water Boilers, 1 Steam

NUMBER OF PUMP(S) HEATING. (3) 2 Heating, 1 Boiler Feed

	DAILY OPERATION.	NIGHT WEEKEND & HOLIDAY OPERATION.
NO. OF BOILER ON-LINE	3 During Heating Season 1 365 Days A Year	24 Hrs A Day 7 Days A Week 1 Lead Boiler, 1 Lag Boiler
NO. OF PUMP ON-LINE	3 During Heat Season 1-365 Days A Year	

BOILER SHUTDOWN BY OUTSIDE AIR TEMP ____ NO
X YES 70°F TEMP

MONITOR X DAILY ____ WEEKLY Blow Down of Controls

COMMENTS

1 Steam Boiler Maintains Domestic hot Water + Dishwasher Hot Water For Mess Hall

2 Hot Water Boilers Maintain Water Temp. For Heating System By Inside, Outside Temp. Controller

JOB 3002.000 Ft. Sill Central Plant

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SHEET NO. ______ OF ______

CALCULATED BY KC DATE 2/8/91

CHECKED BY ______ DATE ______

SCALE ______

BOILER SURVEY FORM

BOILER #1

BOILER MFG.: BIRCHFIELD LOCATION: 4701

BOILER TYPE: STEAM [X] 100 PSI HOT WATER [ ] ______ DEG. F SET POINT

MODEL NO. FBH 578

BOILER'S CAPACITY: MAX BTUH OUTPUT: 1,100,000

MAX BTUH INPUT: ______

BOILER FUEL: OIL [ ] # ______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: HONEYWELL R4140L1089 2

TYPE GP-301

STACK TEST:

TEST 1

OAT= 66 °F

OARH= 29%RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2	5.2	4.2	4.9	4.7
TEMP (F)	434	475	481	486
CO	20	34	30	31
% EFF	80.3	78.9	78.9	79.2

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

- FUEL-AIR RATIO NOT SET IN PAST 5 YEARS.
- ORSAT NOT USED
- LOGS KEPT BUT VALUES FOR CO_2 & STACK TEMP. SIMPLY GUESSED
- OIL CAPABLE - NOT USED FOR YEARS.

JOB 3002.000 Ft. Sill Central Plant

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SHEET NO. ______ OF ______

CALCULATED BY KC DATE 2/8/91

CHECKED BY ______ DATE ______

SCALE ______

BOILER SURVEY FORM

BOILER #2

BOILER MFG.: BIRCHFIELD LOCATION: 4701

BOILER TYPE: STEAM [X] 100 PSI HOT WATER [ ] ______ DEG. F SET POINT

MODEL NO. FBH 578

BOILER'S CAPACITY: MAX BTUH OUTPUT: 1,100,000

MAX BTUH INPUT: ______

BOILER FUEL: OIL [ ] # ______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: HONEYWELL R4140L 089 2

TYPE GP-301

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

- NOT OPERATING.

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JOB 3002.000 Ft. Sill Central Plant
SHEET NO. ______ OF ______
CALCULATED BY KC DATE 2/8/91
CHECKED BY ______ DATE ______
SCALE ______

BOILER SURVEY FORM

BOILER #3

BOILER MFG.: BIRCHFIELD
BOILER TYPE: STEAM [X] 100 PSI
LOCATION: 4701
HOT WATER [ ] ______ DEG. F SET POINT
MODEL NO. FBH 578
BOILER'S CAPACITY: MAX BTUH OUTPUT: 1,100,000
MAX BTUH INPUT: ______
BOILER FUEL: OIL [ ] #______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______
MODEL NO. ______
BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]
SEASONAL SWITCH OVER: SUMMER ______ TO ______
WINTER ______ TO ______

CONTROL MFG.: HONEYWELL GP-301 R 4140L1089 2

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2	8.3	3.9	4.8	5.2
TEMP (F)	418	457	470	474
CO	19	37	37	35
% EFF	78.7	79.5	79.5	79.2

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS: SAME AS BOILER #1

JOB 3002.000 Ft. Sill Central Plant

SHEET NO. ________ OF ________

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CALCULATED BY JW DATE 2/8/91

CHECKED BY ________ DATE ________

SCALE ________

BOILER SURVEY FORM

BOILER # 1

BOILER MFG.: AMERICAN STANDARD

LOCATION: 5676

BOILER TYPE: STEAM [ ] ________ PSI HOT WATER [X] 168 DEG. F SET POINT

MODEL NO. PF515

BOILER'S CAPACITY: MAX BTUH OUTPUT: 2,440,000

MAX BTUH INPUT: 2,975,000

BOILER FUEL: OIL [ ] # ________ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: -

MODEL NO.

BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ________ TO ________

WINTER ________ TO ________

CONTROL MFG.: BURNHAM M# R10.9-GO-15

STACK TEST:

TEST 1

OAT = 49°F

OARH = 68 %RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2	14.8			4.6
TEMP (F)	308			607
CO_2 %	3.4			9.2
% EFF	74 %			75.1 %

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS: DUAL PIPE SYSTEM

SLOTTED LEVER ARM FUEL, AIR ADJUST = TYPE I

NOT SET WITH ORSAT BY O&M

3 WAY VALVE OSA

HWS RESET TEMP,

SERVES DORMS, THEREFORE HEAT RECOVERY CANDIDATE

- 2HWP.

- DOMESTIC HOT WATER BOILER

	TEMP.	O_2	CO_2
BL #1	4.2	436	9.4
BL #2	2.8	441	10.2

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JOB 3002.000 Ft. Sill Central Plant
SHEET NO. ______ OF ______
CALCULATED BY KC DATE 2/8/91
CHECKED BY ______ DATE ______
SCALE ______

BOILER SURVEY FORM

BOILER #2

BOILER MFG.: AMERICAN STANDARD
LOCATION: 5676
BOILER TYPE: STEAM [ ] ______ PSI HOT WATER [X] 168 DEG. F SET POINT
MODEL NO. PF 515
BOILER'S CAPACITY: MAX BTUH OUTPUT: 2,440,000
MAX BTUH INPUT: 2,975,000
BOILER FUEL: OIL [ ] #______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______
MODEL NO. ______
BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]
SEASONAL SWITCH OVER: SUMMER ______ TO ______
WINTER ______ TO ______

CONTROL MFG.: BURNHAM M# R10.9-60-15

STACK TEST:

TEST 1

OAT = 49°F
OARH = 68% RH.

	LOW FIRE	50%	75%	HIGH FIRE
%O2	11.8			5.0
TEMP (F)	453			740
CO	0.3%			0.2%
% EFF	72.9%			71.4%

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

SAME AS BOILER #1

BOILER SURVEY FORM.

BLDG. NO. 5676 DATE ______

OPERATOR NAME Sammie Guffin

NUMBER OF BOILER(S) 2

NUMBER OF PUMP(S) HEATING. 2

	DAILY OPERATION.	NIGHT WEEKEND & HOLIDAY OPERATION.
NO. OF BOILER ON-LINE 2		
NO. OF PUMP ON-LINE 1		

BOILER SHUTDOWN BY OUTSIDE AIR TEMP ✓ NO ___ YES ___ TEMP

MONITOR ___ DAILY ✓ WEEKLY

COMMENTS

JOB 3002.000 Ft. Sill Central Plant

SHEET NO. ______ OF ______

CALCULATED BY JW DATE 2/8/91

CHECKED BY ______ DATE ______

SCALE ______

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BOILER SURVEY FORM

BOILER #1

BOILER MFG.: BURNHAM LOCATION: 5678

BOILER TYPE: STEAM [ ] ______ PSI HOT WATER [X] 168 DEG. F SET POINT

MODEL NO. PF-514

BOILER'S CAPACITY: MAX BTUH OUTPUT: 2,272,000

MAX BTUH INPUT: 2,779,000

BOILER FUEL: OIL [ ] # ______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER OCT. TO MAR.

CONTROL MFG.: WEBSTER M# JZG-07-R4140-L.20

STACK TEST:

TEST 1

OAT = 49°F

OARH = 68% RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2	17.5			15.4
TEMP (F)	310			430
CO	.137%			.132%
% EFF	74%			67.5%

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

SAME AS 5676

— HOT WATER BOILERS (DOMESTIC)

	TEMP	O2
BL #1	430	15.4 %
BL #2	454	12 %

— 4 HWP IN PARALLEL
2 DTWP.

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JOB 3002.000 Ft. Sill Central Plant

SHEET NO. ______ OF ______

CALCULATED BY KC DATE 2/8/91

CHECKED BY ______ DATE ______

SCALE ______

BOILER SURVEY FORM

BOILER #2

BOILER MFG.: BURNHAM

LOCATION: 5678

BOILER TYPE: STEAM [ ] ______ PSI HOT WATER [X] 168 DEG. F SET POINT

MODEL NO. PF-514

BOILER'S CAPACITY: MAX BTUH OUTPUT: 2,272,000

MAX BTUH INPUT: 2,779,000

BOILER FUEL: OIL [ ] # ______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER OCT TO MAR

CONTROL MFG.: WEBSTER MH J20-07-R4140-L.20

STACK TEST:

TEST 1

OAT = 49 F
OAT = 68 % RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2	15.5			12
TEMP (F)	286			454
CO	0%			0%
% EFF	76.6			73.3

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

SAME AS BOILER #1

BOILER SURVEY FORM.

BLDG. NO. 5678 DATE 2-12-91

OPERATOR NAME Sammie Guffin

NUMBER OF BOILER(S) 2

NUMBER OF PUMP(S) HEATING. 5

	DAILY OPERATION.	NIGHT WEEKEND & HOLIDAY OPERATION.
NO. OF BOILER ON-LINE 2		
NO. OF PUMP ON-LINE 4		

BOILER SHUTDOWN BY OUTSIDE AIR TEMP X NO
___ YES ___ TEMP

MONITOR ___ DAILY ✓ WEEKLY

COMMENTS

JOB	3002.000 Ft. Sill Central Plant
SHEET NO.	OF
CALCULATED BY	JW DATE 2/9/91
CHECKED BY	DATE
SCALE	

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BOILER SURVEY FORM

BOILER # 1

BOILER MFG.: INTERNATIONAL BOILER WORKS LOCATION: 5903

BOILER TYPE: STEAM [ ] ______ PSI HOT WATER [X] 380 DEG. F SET POINT

MODEL NO. 11633

BOILER'S CAPACITY: MAX BTUH OUTPUT: 10,000,000

MAX BTUH INPUT: ______

BOILER FUEL: OIL [ ] # ______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: BRISTOL

STACK TEST:

TEST 1

OAT = 60 °F

OARH = 45% RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2	6.1	5.9	5.6	7
TEMP (F)	558	595	660	702
CO	10 PPM	17 PPM	14 PPM	14 PPM
% EFF	76.3	75.2	73.7	70.9

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS: BOILER PANELS HAVE RECORDING O_2, STACK TEMP., BUT ARE NOT CALIBRATED. PLANT HAS ORSAT USED IN SETTING FLUE GAS RATIO.

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SHEET NO. ______ OF ______

CALCULATED BY JW DATE 2/9/91

CHECKED BY ______ DATE ______

SCALE ______

BOILER SURVEY FORM

BOILER # 2

BOILER MFG.: INTERNATIONAL BOILER WORKS LOCATION: 5900

BOILER TYPE: STEAM [ ] ______ PSI HOT WATER [x] 380 DEG. F SET POINT

MODEL NO. 11633

BOILER'S CAPACITY: MAX BTUH OUTPUT: 10,000,000

MAX BTUH INPUT: ______

BOILER FUEL: OIL [ ] # ______ GAS [ ] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [x] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: BRISTOL

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2	6.6	1.4		5.0
TEMP (F)	500	590		690
CO	15 PPM	25 PPM		42 PPM
% EFF	77.5	78		73.2.

OAT = 60°F

OARH = 45% RH

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS: FIVE PUMPS IN PARALLEL SERVE ALL BOILERS

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SHEET NO. ______ OF ______
CALCULATED BY JW DATE 2/9/91
CHECKED BY ______ DATE ______
SCALE ______

BOILER SURVEY FORM

BOILER #3

BOILER MFG.: HERCULES BOILER CO. LOCATION: 5900
BOILER TYPE: STEAM [ ] ______ PSI HOT WATER [X] 385 DEG. F SET POINT
MODEL NO. 300
BOILER'S CAPACITY: MAX BTUH OUTPUT: 9,700,000
MAX BTUH INPUT: ______
BOILER FUEL: OIL [ ] # ______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______
MODEL NO. ______
BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]
SEASONAL SWITCH OVER: SUMMER ______ TO ______
WINTER ______ TO ______

CONTROL MFG.: HONEYWELL

STACK TEST:

TEST 1

OAT = 60°F
OARH = 45%RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2	10.9	5.2	4.7	5.5
TEMP (F)	303	400	405	434
CO	3 PPM	11 PPM	14 PPM	25 PPM
% EFF	80.7	81.2	81	80

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS: DESIGN $\Delta P \approx 75$ PSI

THE ΔP HTHW CONTROL DOES NOT OPERATE.
OPERATORS PUT PUMPS ON AND OFF LINE TO VARY FLOW AND CONTROL.

JOB 3002.000 Ft. Sill Central Plant

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SHEET NO. ______ OF ______

CALCULATED BY JW DATE 2/9/91

CHECKED BY ______ DATE ______

SCALE ______

BOILER SURVEY FORM

BOILER #4

BOILER MFG.: HERCULES BOILER LOCATION: 5900

BOILER TYPE: STEAM [ ] ______ PSI HOT WATER [x] 385 DEG. F SET POINT

MODEL NO. 300

BOILER'S CAPACITY: MAX BTUH OUTPUT: 9,700,000

MAX BTUH INPUT: ______

BOILER FUEL: OIL [ ] # ______ GAS [x] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [x] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: HONEYWELL

STACK TEST:

TEST 1

OAT = 60 °F

OARH = 45%RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2	12.6	6.4	4.7	5.9
TEMP (F)	231	400	418	440
CO	2.95%	0.8%	0.2%	0.09%
% EFF	82.4	80.5	81	79.6

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS: HTHWR TEMP. AT ≈ 250°F

(HTHWS IS VARIED FROM ≈ 310°F TO 340°F WITH OSA.

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JOB 3002.000 Ft. Sill Central Plant

SHEET NO. ______ OF ______

CALCULATED BY JW DATE 2/9/91

CHECKED BY ______ DATE ______

SCALE ______

BOILER SURVEY FORM

BOILER #5

BOILER MFG.: INTERNATIONAL BOILER WORKS LOCATION: 5900

BOILER TYPE: STEAM [ ] ______ PSI HOT WATER [X] 380 DEG. F SET POINT

MODEL NO. THIZ

BOILER'S CAPACITY: MAX BTUH OUTPUT: 8,000,000

MAX BTUH INPUT: ______

BOILER FUEL: OIL [ ] #______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: N/A

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2	9.5	8.2	6.9	5.6
TEMP (F)	350	410	440	465
CO	55 PPM	24 PPM	16 PPM	17 PPM
% EFF	80.3	79.1	79	79.2

OAT = 60°F

OARH = 45%RH

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

JOB 3002.000 Ft. Sill Central Plant

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SHEET NO. ________ OF ________

CALCULATED BY JW DATE 2/9/91

CHECKED BY ________ DATE ________

SCALE ________

BOILER SURVEY FORM

BOILER #6

BOILER MFG.: INTERNATIONAL BOILER WORKS LOCATION: 5900

BOILER TYPE: STEAM [ ] ________ PSI HOT WATER [X] 380 DEG. F SET POINT

MODEL NO. TJW-C-10

BOILER'S CAPACITY: MAX BTUH OUTPUT: 11,200,000

MAX BTUH INPUT: ________

BOILER FUEL: OIL [ ] # ________ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ________

MODEL NO. ~~TJW-C-10~~

BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ________ TO ________

WINTER ________ TO ________

CONTROL MFG.: Fire eye TYPE 72DIR1

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2	8.4	8.0	6.9	5.4
TEMP (F)	371	360	389	402
CO	0%	0%	0%	0%
% EFF	80	80.7	80.6	80.8

OAT = 60 °F

OARH = 45 %RH.

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

BOILER SURVEY FORM.

BLDG. NO. 5900 DATE 2-12-91

OPERATOR NAME Roger Coody

NUMBER OF BOILER(S) As Required 6

NUMBER OF PUMP(S) HEATING. As Required 11

	DAILY OPERATION.	NIGHT WEEKEND & HOLIDAY OPERATION.
NO. OF BOILER ON-LINE 2	As Required by Load	
NO. OF PUMP ON-LINE 6	As Required by Load	

BOILER SHUTDOWN BY OUTSIDE AIR TEMP ✓ NO ___ YES ___ TEMP

MONITOR ___ DAILY ___ WEEKLY

COMMENTS

Boilers Are monitored Hourly Winter operation Idle Boilers Heated by Trickle To maintain 1 Standby Boiler min

JOB 3002.000 Ft. Sill Central Plant

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

SHEET NO. ______ OF ______

CALCULATED BY JW DATE 2/11/91

CHECKED BY ______ DATE ______

SCALE ______

BOILER SURVEY FORM

BOILER #1

BOILER MFG.: KEWANEE BOILER CO LOCATION: 6003

BOILER TYPE: STEAM [X] 15 PSI HOT WATER [ ] ______ DEG. F SET POINT

MODEL NO. L3S-350-GOS

BOILER'S CAPACITY: MAX BTUH OUTPUT: 11,716,000

MAX BTUH INPUT:

BOILER FUEL: OIL [ ] # ______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.:

MODEL NO.

BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: GORDON - PIATT # GP 2840

STACK TEST:

TEST 1

OAT = 60 °F
OARH = 42% RH

	LOW FIRE	50%	75%	HIGH FIRE
%O2	15.2	9.1	6.4	6.6
TEMP (F)	271	322	335	337
CO	0	0	0	0
% EFF	77.2	82.4	82.3	82.3

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS:

- LOW FIRE NEEDS ADJ. FOR LESS AIR
- SAFETY VALVES: DISTANCE TO DRIP PAN TOO GREAT.
- GOOD CONTROL
- SUMMER ONLY #3 RUN
- WINTER EITHER #1 OR #2 RUN

JOB 3002.000 Ft. Sill Central Plant

SHEET NO. ______ OF ______

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

CALCULATED BY JW DATE 2/4/91

CHECKED BY ______ DATE ______

SCALE ______

BOILER SURVEY FORM

BOILER MFG.: YORK SHIPLEY - STEAM PAK LOCATION: BOILER #2 6003

BOILER TYPE: STEAM [X] ~~30~~ 15 PSI HOT WATER [ ] ______ DEG. F SET POINT

MODEL NO. SPL-350-11

BOILER'S CAPACITY: MAX BTUH OUTPUT: N/A 11,718,000

MAX BTUH INPUT:

BOILER FUEL: OIL [ ] # ______ GAS [X] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: HONEYWELL BC 7000

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2	10.4	13	12.7	11.9
TEMP (F)	250	263	290	303
CO	47	575	280 PPM	200 PPM
% EFF	82.9	80.6	80	79.8

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS: ECO:
REMOVE BOILER #2 & REPLACE WITH SMALL SUMMER BOILER.

JOB 3002.000 Ft. Sill Central Plant

SHEET NO. ______ OF ______

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

CALCULATED BY JW DATE 2/11/91

CHECKED BY ______ DATE ______

SCALE ______

BOILER SURVEY FORM

BOILER #3

BOILER MFG.: KEWANEE BOILER LOCATION: 6003 FAR LEFT

BOILER TYPE: STEAM [x] 15 PSI HOT WATER [ ] ______ DEG. F SET POINT

MODEL NO. L35 350 -KGOS

BOILER'S CAPACITY: MAX BTUH OUTPUT: 11,716,000

MAX BTUH INPUT: ______

BOILER FUEL: OIL [ ] # ______ GAS [x] ELECTRIC [ ] OTHER [ ]

BURNER MFG.: ______

MODEL NO. ______

BURNER TYPE FORCE AIR [X] OPEN FLAME [ ]

SEASONAL SWITCH OVER: SUMMER ______ TO ______

WINTER ______ TO ______

CONTROL MFG.: HONEYWELL R4140G.

STACK TEST:

TEST 1

	LOW FIRE	50%	75%	HIGH FIRE
%O2	14.2	8.6	10	*
TEMP (F)	240	295	310	
CO	293 PPM	21 PPM	21 PPM	
% EFF	80.4	82.6	81.1	

TEST 2

	LOW FIRE	50%	75%	HIGH FIRE
%O2				
TEMP (F)				
CO				
% EFF				

COMMENTS: *LINKAGE FELL OFF OF GAS FIRING VL-OPR

EITHER BOILER NO. 1 OR NO. 3 SUFFICIENT FOR WINTER.

BOILER SURVEY FORM.

BLDG. NO. 6003 DATE 2-11-91

OPERATOR NAME Dennis Shaw

NUMBER OF BOILER(S) 3

NUMBER OF PUMP(S) HEATING. ______

	DAILY OPERATION.	NIGHT WEEKEND & HOLIDAY OPERATION.
NO. OF BOILER ON-LINE 2	WINTER 2 Summer 1	SAME SAME
NO. OF PUMP ON-LINE 2	WINTER 2 SUMMER 1	SAME SAME

BOILER SHUTDOWN BY OUTSIDE AIR TEMP ✓ NO ____ YES ____ TEMP

MONITOR ✓ DAILY ____ WEEKLY

COMMENTS

BOILER COMBUSTION EFFICEINCY TABLE
FOR NATUARAL GAS

Table B.1 COMBUSTION EFFICIENCY TABLES FOR NATURAL GAS

NATURAL GAS

EXCESS AIR	% O_2	% CO_2	COMBUSTION EFFICIENCY — FLUE GAS TEMPERATURE LESS COMBUSTION AIR TEMPERATURE, DEG F 170	180	190	200	210	220	230	240	250	260	270	280	290	300
0.0	0.0	11.8	86.3	86.1	85.9	85.7	85.5	85.3	85.1	84.9	84.7	84.5	84.2	84.0	83.8	83.6
2.2	0.5	11.5	86.3	86.1	85.9	85.6	85.4	85.2	85.0	84.8	84.6	84.4	84.1	83.9	83.7	83.5
4.5	1.0	11.2	86.2	86.0	85.8	85.6	85.3	85.1	84.9	84.7	84.5	84.2	84.0	83.8	83.6	83.4
6.9	1.5	11.0	86.1	85.9	85.7	85.5	85.2	85.0	84.8	84.6	84.4	84.1	83.9	83.7	83.5	83.2
9.5	2.0	10.7	86.1	85.8	85.6	85.4	85.2	84.9	84.7	84.5	84.2	84.0	83.8	83.6	83.3	83.1
12.1	2.5	10.4	86.0	85.7	85.5	85.3	85.1	84.8	84.6	84.4	84.1	83.9	83.7	83.4	83.2	83.0
15.0	3.0	10.1	85.9	85.7	85.4	85.2	85.0	84.7	84.5	84.2	84.0	83.8	83.5	83.3	83.0	82.8
18.0	3.5	9.8	85.8	85.6	85.3	85.1	84.8	84.6	84.4	84.1	83.9	83.6	83.4	83.1	82.9	82.6
21.1	4.0	9.6	85.7	85.5	85.2	85.0	84.7	84.5	84.2	84.0	83.7	83.5	83.2	83.0	82.7	82.5
24.5	4.5	9.3	85.6	85.4	85.1	84.8	84.6	84.3	84.1	83.8	83.6	83.3	83.1	82.8	82.6	82.3
28.1	5.0	9.0	85.5	85.2	85.0	84.7	84.5	84.2	83.9	83.7	83.4	83.2	82.9	82.6	82.4	82.1
31.9	5.5	8.7	85.4	85.1	84.9	84.6	84.3	84.1	83.8	83.5	83.3	83.0	82.7	82.4	82.2	81.9
35.9	6.0	8.4	85.3	85.0	84.7	84.4	84.2	83.9	83.6	83.3	83.1	82.8	82.5	82.2	82.0	81.7
40.3	6.5	8.2	85.1	84.9	84.6	84.3	84.0	83.7	83.4	83.2	82.9	82.6	82.3	82.0	81.7	81.5
44.9	7.0	7.9	85.0	84.7	84.4	84.1	83.8	83.5	83.3	83.0	82.7	82.4	82.1	81.8	81.5	81.2
49.9	7.5	7.6	84.8	84.5	84.2	84.0	83.7	83.4	83.1	82.8	82.5	82.2	81.9	81.6	81.3	80.9
55.3	8.0	7.3	84.7	84.4	84.1	83.8	83.5	83.1	82.8	82.5	82.2	81.9	81.6	81.3	81.0	80.7
61.1	8.5	7.0	84.5	84.2	83.9	83.6	83.2	82.9	82.6	82.3	82.0	81.6	81.3	81.0	80.7	80.4
67.3	9.0	6.7	84.3	84.0	83.7	83.3	83.0	82.7	82.3	82.0	81.7	81.4	81.0	80.7	80.4	80.0
74.2	9.5	6.5	84.1	83.8	83.4	83.1	82.8	82.4	82.1	81.7	81.4	81.0	80.7	80.3	80.0	79.7
81.6	10.0	6.2	83.9	83.5	83.2	82.8	82.5	82.1	81.8	81.4	81.1	80.7	80.3	80.0	79.6	79.3
89.8	10.5	5.9	83.6	83.3	82.9	82.5	82.2	81.8	81.4	81.1	80.7	80.3	79.9	79.6	79.2	78.8
98.7	11.0	5.6	83.4	83.0	82.6	82.2	81.8	81.5	81.1	80.7	80.3	79.9	79.5	79.1	78.7	78.3
108.7	11.5	5.3	83.1	82.7	82.3	81.9	81.5	81.1	80.7	80.3	79.9	79.4	79.0	78.6	78.2	77.8
119.7	12.0	5.1	82.7	82.3	81.9	81.5	81.1	80.6	80.2	79.8	79.4	78.9	78.5	78.1	77.7	77.2
132.0	12.5	4.8	82.4	81.9	81.5	81.0	80.6	80.2	79.7	79.3	78.8	78.4	77.9	77.5	77.0	76.6
145.8	13.0	4.5	82.0	81.5	81.0	80.6	80.1	79.6	79.1	78.7	78.2	77.7	77.3	76.8	76.3	75.8
161.5	13.5	4.2	81.5	81.0	80.5	80.0	79.5	79.0	78.5	78.0	77.5	77.0	76.5	76.0	75.5	75.0
179.5	14.0	3.9	81.0	80.4	79.9	79.4	78.8	78.3	77.8	77.2	76.7	76.2	75.7	75.1	74.6	74.0
200.2	14.5	3.7	80.3	79.8	79.2	78.6	78.1	77.5	76.9	76.4	75.8	75.2	74.7	74.1	73.5	72.9
224.3	15.0	3.4	79.6	79.0	78.4	77.8	77.2	76.6	76.0	75.3	74.7	74.1	73.5	72.9	72.3	71.7

Table B.1 COMBUSTION EFFICIENCY TABLES FOR NATURAL GAS

NATURAL GAS

EXCESS AIR	% O_2	% CO_2	COMBUSTION EFFICIENCY — FLUE GAS TEMPERATURE LESS COMBUSTION AIR TEMPERATURE, DEG F													
			310	320	330	340	350	360	370	380	390	400	410	420	430	440
0.0	0.0	11.8	83.4	83.2	83.0	82.8	82.5	82.3	82.1	81.9	81.7	81.5	81.2	81.0	80.8	80.6
2.2	0.5	11.5	83.3	83.1	82.8	82.6	82.4	82.2	82.0	81.7	81.5	81.3	81.1	80.9	80.6	80.4
4.5	1.0	11.2	83.1	82.9	82.7	82.5	82.3	82.0	81.8	81.6	81.4	81.1	80.9	80.7	80.5	80.2
6.9	1.5	11.0	83.0	82.8	82.6	82.3	82.1	81.9	81.6	81.4	81.2	81.0	80.7	80.5	80.3	80.0
9.5	2.0	10.7	82.9	82.6	82.4	82.2	81.9	81.7	81.5	81.2	81.0	80.8	80.5	80.3	80.1	79.8
12.1	2.5	10.4	82.7	82.5	82.3	82.0	81.8	81.5	81.3	81.1	80.8	80.6	80.3	80.1	79.9	79.6
15.0	3.0	10.1	82.6	82.3	82.1	81.8	81.6	81.4	81.1	80.9	80.6	80.4	80.1	79.9	79.7	79.4
18.0	3.5	9.8	82.4	82.2	81.9	81.7	81.4	81.2	80.9	80.7	80.4	80.2	79.9	79.7	79.4	79.2
21.1	4.0	9.6	82.2	82.0	81.7	81.5	81.2	81.0	80.7	80.5	80.2	79.9	79.7	79.4	79.2	78.9
24.5	4.5	9.3	82.0	81.8	81.5	81.3	81.0	80.8	80.5	80.2	80.0	79.7	79.4	79.2	78.9	78.7
28.1	5.0	9.0	81.8	81.6	81.3	81.1	80.8	80.5	80.3	80.0	79.7	79.5	79.2	78.9	78.6	78.4
31.9	5.5	8.7	81.6	81.4	81.1	80.8	80.6	80.3	80.0	79.7	79.5	79.2	78.9	78.6	78.4	78.1
35.9	6.0	8.4	81.4	81.1	80.9	80.6	80.3	80.0	79.7	79.5	79.2	78.9	78.6	78.3	78.0	77.8
40.3	6.5	8.2	81.2	80.9	80.6	80.3	80.0	79.7	79.5	79.2	78.9	78.6	78.3	78.0	77.7	77.4
44.9	7.0	7.9	80.9	80.6	80.3	80.0	79.7	79.4	79.1	78.8	78.5	78.2	77.9	77.6	77.3	77.0
49.9	7.5	7.6	80.6	80.3	80.0	79.7	79.4	79.1	78.8	78.5	78.2	77.9	77.6	77.3	77.0	76.7
55.3	8.0	7.3	80.4	80.0	79.7	79.4	79.1	78.8	78.5	78.1	77.8	77.5	77.2	76.9	76.6	76.2
61.1	8.5	7.0	80.0	79.7	79.4	79.1	78.7	78.4	78.1	77.8	77.4	77.1	76.8	76.4	76.1	75.8
67.3	9.0	6.7	79.7	79.3	79.0	78.7	78.3	78.0	77.7	77.3	77.0	76.6	76.3	76.0	75.6	75.3
74.2	9.5	6.5	79.3	79.0	78.6	78.3	77.9	77.6	77.2	76.9	76.5	76.2	75.8	75.5	75.1	74.7
81.6	10.0	6.2	78.9	78.5	78.2	77.8	77.5	77.1	76.7	76.4	76.0	75.6	75.3	74.9	74.5	74.2
89.8	10.5	5.9	78.4	78.1	77.7	77.3	76.9	76.6	76.2	75.8	75.4	75.0	74.7	74.3	73.9	73.5
98.7	11.0	5.6	78.0	77.6	77.2	76.8	76.4	76.0	75.6	75.2	74.8	74.4	74.0	73.6	73.2	72.8
108.7	11.5	5.3	77.4	77.0	76.6	76.2	75.8	75.4	74.9	74.5	74.1	73.7	73.3	72.9	72.4	72.0
119.7	12.0	5.1	76.8	76.4	75.9	75.5	75.1	74.6	74.2	73.8	73.3	72.9	72.5	72.0	71.6	71.2
132.0	12.5	4.8	76.1	75.7	75.2	74.8	74.3	73.9	73.4	72.9	72.5	72.0	71.6	71.1	70.6	70.2
145.8	13.0	4.5	75.4	74.9	74.4	73.9	73.4	73.0	72.5	72.0	71.5	71.0	70.6	70.1	69.6	69.1
161.5	13.5	4.2	74.5	74.0	73.5	73.0	72.5	72.0	71.5	70.9	70.4	69.9	69.4	68.9	68.4	67.9
179.5	14.0	3.9	73.5	73.0	72.4	71.9	71.4	70.8	70.3	69.7	69.2	68.6	68.1	67.5	67.0	66.4
200.2	14.5	3.7	72.4	71.8	71.2	70.6	70.1	69.5	68.9	68.3	67.7	67.2	66.6	66.0	65.4	64.8
224.3	15.0	3.4	71.0	70.4	69.8	69.2	68.6	67.9	67.3	66.7	66.1	65.4	64.8	64.2	63.5	62.9

Table B.1 COMBUSTION EFFICIENCY TABLES FOR NATURAL GAS

NATURAL GAS

EXCESS AIR	% O_2	% CO_2	COMBUSTION EFFICIENCY: FLUE GAS TEMPERATURE LESS COMBUSTION AIR TEMPERATURE, DEG F 450	460	470	480	490	500	510	520	530	540	550	560	570	580
0.0	0.0	11.8	80.4	80.1	79.9	79.7	79.5	79.3	79.0	78.8	78.6	78.4	78.1	77.9	77.7	77.5
2.2	0.5	11.5	80.2	80.0	79.7	79.5	79.3	79.1	78.8	78.6	78.4	78.2	77.9	77.7	77.5	77.2
4.5	1.0	11.2	80.0	79.8	79.5	79.3	79.1	78.9	78.6	78.4	78.2	77.9	77.7	77.5	77.2	77.0
6.9	1.5	11.0	79.8	79.6	79.3	79.1	78.9	78.6	78.4	78.2	77.9	77.7	77.5	77.2	77.0	76.8
9.5	2.0	10.7	79.6	79.4	79.1	78.9	78.7	78.4	78.2	77.9	77.7	77.5	77.2	77.0	76.7	76.5
12.1	2.5	10.4	79.4	79.1	78.9	78.7	78.4	78.2	77.9	77.7	77.4	77.2	76.9	76.7	76.5	76.2
15.0	3.0	10.1	79.2	78.9	78.7	78.4	78.2	77.9	77.7	77.4	77.2	76.9	76.7	76.4	76.2	75.9
18.0	3.5	9.8	78.9	78.7	78.4	78.2	77.9	77.6	77.4	77.1	76.9	76.6	76.4	76.1	75.9	75.6
21.1	4.0	9.6	78.7	78.4	78.1	77.9	77.6	77.4	77.1	76.8	76.6	76.3	76.1	75.8	75.5	75.3
24.5	4.5	9.3	78.4	78.1	77.9	77.6	77.3	77.1	76.8	76.5	76.3	76.0	75.7	75.4	75.2	74.9
28.1	5.0	9.0	78.1	77.8	77.6	77.3	77.0	76.7	76.5	76.2	75.9	75.6	75.4	75.1	74.8	74.5
31.9	5.5	8.7	77.8	77.5	77.2	77.0	76.7	76.4	76.1	75.8	75.6	75.3	75.0	74.7	74.4	74.1
35.9	6.0	8.4	77.5	77.2	76.9	76.6	76.3	76.0	75.7	75.5	75.2	74.9	74.6	74.3	74.0	73.7
40.3	6.5	8.2	77.1	76.8	76.5	76.2	75.9	75.6	75.3	75.1	74.8	74.5	74.2	73.9	73.6	73.3
44.9	7.0	7.9	76.7	76.4	76.1	75.8	75.5	75.2	74.9	74.6	74.3	74.0	73.7	73.4	73.1	72.8
49.9	7.5	7.6	76.3	76.0	75.7	75.4	75.1	74.8	74.5	74.1	73.8	73.5	73.2	72.9	72.6	72.2
55.3	8.0	7.3	75.9	75.6	75.3	74.9	74.6	74.3	74.0	73.6	73.3	73.0	72.7	72.3	72.0	71.7
61.1	8.5	7.0	75.4	75.1	74.8	74.4	74.1	73.8	73.4	73.1	72.8	72.4	72.1	71.8	71.4	71.1
67.3	9.0	6.7	74.9	74.6	74.2	73.9	73.6	73.2	72.9	72.5	72.2	71.8	71.5	71.1	70.8	70.4
74.2	9.5	6.5	74.4	74.0	73.7	73.3	73.0	72.6	72.2	71.9	71.5	71.2	70.8	70.4	70.1	69.7
81.6	10.0	6.2	73.8	73.4	73.0	72.7	72.3	71.9	71.6	71.2	70.8	70.4	70.1	69.7	69.3	68.9
89.8	10.5	5.9	73.1	72.7	72.4	72.0	71.6	71.2	70.8	70.4	70.0	69.6	69.2	68.9	68.5	68.1
98.7	11.0	5.6	72.4	72.0	71.6	71.2	70.8	70.4	70.0	69.6	69.2	68.8	68.4	67.9	67.5	67.1
108.7	11.5	5.3	71.6	71.2	70.8	70.3	69.9	69.5	69.1	68.6	68.2	67.8	67.4	66.9	66.5	66.1
119.7	12.0	5.1	70.7	70.3	69.8	69.4	68.9	68.5	68.1	67.6	67.2	66.7	66.3	65.8	65.4	64.9
132.0	12.5	4.8	69.7	69.3	68.8	68.3	67.9	67.4	66.9	66.5	66.0	65.5	65.1	64.6	64.1	63.6
145.8	13.0	4.5	68.6	68.1	67.6	67.1	66.6	66.2	65.7	65.2	64.7	64.2	63.7	63.2	62.7	62.2
161.5	13.5	4.2	67.3	66.8	66.3	65.8	65.3	64.7	64.2	63.7	63.2	62.6	62.1	61.6	61.1	60.5
179.5	14.0	3.9	65.9	65.3	64.8	64.2	63.7	63.1	62.6	62.0	61.5	60.9	60.3	59.8	59.2	58.7
200.2	14.5	3.7	64.2	63.6	63.1	62.5	61.9	61.3	60.7	60.1	59.5	58.9	58.3	57.7	57.1	56.5
224.3	15.0	3.4	62.3	61.7	61.0	60.4	59.7	59.1	58.5	57.8	57.2	56.5	55.9	55.3	54.6	54.0

Table B.1 COMBUSTION EFFICIENCY TABLES FOR NATURAL GAS

NATURAL GAS

EXCESS AIR	% O_2	% CO_2	COMBUSTION EFFICIENCY: FLUE GAS TEMPERATURE LESS COMBUSTION AIR TEMPERATURE, DEG F 590	600	610	620	630	640	650	660	670	680	690	700	710	720
0.0	0.0	11.8	77.2	77.0	76.8	76.6	76.3	76.1	75.9	75.7	75.4	75.2	75.0	74.7	74.5	74.3
2.2	0.5	11.5	77.0	76.8	76.6	76.3	76.1	75.9	75.6	75.4	75.2	74.9	74.7	74.5	74.2	74.0
4.5	1.0	11.2	76.8	76.5	76.3	76.1	75.8	75.6	75.4	75.1	74.9	74.6	74.4	74.2	73.9	73.7
6.9	1.5	11.0	76.5	76.3	76.0	75.8	75.6	75.3	75.1	74.8	74.6	74.3	74.1	73.9	73.6	73.4
9.5	2.0	10.7	76.2	76.0	75.8	75.5	75.3	75.0	74.8	74.5	74.3	74.0	73.8	73.5	73.3	73.0
12.1	2.5	10.4	76.0	75.7	75.5	75.2	75.0	74.7	74.5	74.2	74.0	73.7	73.4	73.2	72.9	72.7
15.0	3.0	10.1	75.7	75.4	75.1	74.9	74.6	74.4	74.1	73.9	73.6	73.4	73.1	72.8	72.6	72.3
18.0	3.5	9.8	75.3	75.1	74.8	74.6	74.3	74.0	73.8	73.5	73.2	73.0	72.7	72.5	72.2	71.9
21.1	4.0	9.6	75.0	74.7	74.5	74.2	73.9	73.7	73.4	73.1	72.9	72.6	72.3	72.0	71.8	71.5
24.5	4.5	9.3	74.6	74.4	74.1	73.8	73.5	73.3	73.0	72.7	72.4	72.2	71.9	71.6	71.3	71.1
28.1	5.0	9.0	74.3	74.0	73.7	73.4	73.1	72.9	72.6	72.3	72.0	71.7	71.4	71.2	70.9	70.6
31.9	5.5	8.7	73.8	73.6	73.3	73.0	72.7	72.4	72.1	71.8	71.5	71.3	71.0	70.7	70.4	70.1
35.9	6.0	8.4	73.4	73.1	72.8	72.5	72.2	71.9	71.6	71.4	71.1	70.8	70.5	70.2	69.9	69.6
40.3	6.5	8.2	73.0	72.7	72.4	72.0	71.7	71.4	71.1	70.8	70.5	70.2	69.9	69.6	69.3	69.0
44.9	7.0	7.9	72.5	72.1	71.8	71.5	71.2	70.9	70.6	70.3	70.0	69.6	69.3	69.0	68.7	68.4
49.9	7.5	7.6	71.9	71.6	71.3	71.0	70.6	70.3	70.0	69.7	69.4	69.0	68.7	68.4	68.1	67.7
55.3	8.0	7.3	71.4	71.0	70.7	70.4	70.0	69.7	69.4	69.0	68.7	68.4	68.0	67.7	67.4	67.0
61.1	8.5	7.0	70.7	70.4	70.1	69.7	69.4	69.0	68.7	68.3	68.0	67.6	67.3	67.0	66.6	66.3
67.3	9.0	6.7	70.1	69.7	69.4	69.0	68.6	68.3	67.9	67.6	67.2	66.9	66.5	66.2	65.8	65.4
74.2	9.5	6.5	69.3	69.0	68.6	68.2	67.9	67.5	67.1	66.8	66.4	66.0	65.7	65.3	64.9	64.5
81.6	10.0	6.2	68.5	68.2	67.8	67.4	67.0	66.6	66.3	65.9	65.5	65.1	64.7	64.3	63.9	63.6
89.8	10.5	5.9	67.7	67.3	66.9	66.5	66.1	65.7	65.3	64.9	64.5	64.1	63.7	63.3	62.9	62.5
98.7	11.0	5.6	66.7	66.3	65.9	65.5	65.1	64.6	64.2	63.8	63.4	63.0	62.6	62.1	61.7	61.3
108.7	11.5	5.3	65.7	65.2	64.8	64.4	63.9	63.5	63.1	62.6	62.2	61.8	61.3	60.9	60.4	60.0
119.7	12.0	5.1	64.5	64.0	63.6	63.1	62.7	62.2	61.8	61.3	60.8	60.4	59.9	59.5	59.0	58.6
132.0	12.5	4.8	63.2	62.7	62.2	61.7	61.3	60.8	60.3	59.8	59.3	58.9	58.4	57.9	57.4	56.9
145.8	13.0	4.5	61.7	61.2	60.7	60.2	59.7	59.2	58.7	58.2	57.7	57.1	56.6	56.1	55.6	55.1
161.5	13.5	4.2	60.0	59.5	58.9	58.4	57.9	57.3	56.8	56.3	55.7	55.2	54.7	54.1	53.6	53.0
179.5	14.0	3.9	58.1	57.5	57.0	56.4	55.8	55.3	54.7	54.1	53.6	53.0	52.4	51.8	51.3	50.7
200.2	14.5	3.7	55.9	55.3	54.7	54.1	53.5	52.9	52.3	51.6	51.0	50.4	49.8	49.2	48.6	48.0
224.3	15.0	3.4	53.3	52.7	52.0	51.4	50.7	50.1	49.4	48.7	48.1	47.4	46.8	46.1	45.5	44.8

APPENDIX G

CENTRAL HEATING PLANT 3442, DD1391

AR 415-17: Building Cost Index 2158

L4774 Army-Ft. Sill, Okla

MILITARY CONSTRUCTION PROJECT DATA

1. DATE	2. FISCAL YEAR	3. DEPARTMENT	4. INSTALLATION
17 Nov 79	1982	Army	Fort Sill, Oklahoma

5. PROPOSED AUTHORIZATION	6. PRIOR AUTHORIZATION	7. CATEGORY CODE NUMBER	8. PROGRAM ELEMENT NUMBER	9. STATE/COUNTRY
$ 1,941,100.	P.L.	89045		Oklahoma

10. PROPOSED APPROPRIATION	11. BUDGET ACCOUNT NUMBER	12. PROJECT NUMBER	13. PROJECT TITLE	NM	CM	RM
$ 1,941,100.		B408-T497	3442 Central Heating Plant Addition (ECIP)			X

SECTION A - DESCRIPTION OF PROJECT

14. TYPE OF CONSTRUCTION	
a. PERMANENT	X
b. SEMI-PERMANENT	
c. TEMPORARY	
15. TYPE OF WORK	
a. NEW FACILITY	
b. ADDITION	X
c. ALTERATION	
d. CONVERSION	
e. OTHER (Specify)	
16. REPLACEMENT	
17. TYPE OF DESIGN	
a. STANDARD DESIGN	
b. SPECIAL DESIGN	X
c. DRAWING NO.	

18. PHYSICAL CHARACTERISTICS OF PRIMARY FACILITY

a. NO. OF BLDGS N/A b. NO. OF STORIES N/A c. LENGTH 124 d. WIDTH 37

e. DESIGN CAPACITY N/A f. GROSS AREA

g. COOLING N/A CAP. COST ($ N/A)

19. DESCRIPTION OF WORK TO BE DONE Construction of a Central Heating Plant to house boilers & equipment to be an addition to Bldg.#3442 (Existing chilled water central cooling plant). Equipment to include boilers, pumps, controls, meters, recorders for pumping high temperature hot water thru direct-bury transmission piping to existing 23 Barracks Bldg. & Gym. System to replace 48 old gas fired (inefficient) steam boilers w/new equipment for more efficient operation & control. New construction to match existing CMU walls, w/concrete floors; over-head metal doors; steel superstructure & roof w/insulation; unit heaters; fuel oil stg. tanks & pumping system; extension of exist. elect. distrib. from present CHW plant.

SECTION B - COST ESTIMATES

20. PRIMARY FACILITY	U/M	QUANTITY	UNIT COST	COST ($000)
			$	$1,428.
a. Central Plant Addition	SF	(4600)	51.47	(237.)
b. Boilers	Ea	(3)	LS	(1,183.)
c. Pumps	Ea	(3)	LS	(8.)
d.		( )		( )
21. SUPPORTING FACILITIES				$ 507.
a. Piping Distribution			LS	(286.)
b. Retrofit Bldgs.	Ea	24	LS	(79.)
c. Electrical Work			LS	(20.)
d. Site Work			LS	(30.)
e. Fuel Storage Tanks	EA	2	15,000	(30.)
f. Recording Instr. & Controls			LS	(62.)
g. Gas Service			LS	(6.)
h.				( )
i.				( )
j.				( )
22. TOTAL PROJECT COST				$1,941.

SECTION C - BASIS OF REQUIREMENT

23. QUANTITATIVE DATA (U/M N/A)

	AUTHORIZED	FUNDED
a. TOTAL REQUIREMENT		
b. EXISTING SUBSTANDARD	(	)
c. EXISTING ADEQUATE		
d. FUNDED, NOT IN INVENTORY		
e. ADEQUATE ASSETS (c + d)		
f. UNFUNDED PRIOR AUTHORIZATION		
g. INCLUDED IN FY ______ PROGRAM		
h. DEFICIENCY (a - e - f - g)		

24. RELATED PROJECTS

25. REQUIREMENT FOR PROJECT This Central Heating Plant project is required for more efficient plant operation and will significantly reduce energy consumption in 24 existing & permanent buildings. It will have immediate capability of converting natural gas to oil in accordance with AR420-49 18 Nov '76. (a fuel comparison shows fuel-oil more economically justifiable than coal). A continuous detailed surveillance of this plant will enable DFAE to provide for more effective, timely maintenance of new equipment which will replace several inefficient, oversized boilers and pumps that are nearing the end of their economic life. This project has been reviewed and it has been determined that an "environmental impact statement" pursuant to P.L. 91-190 is not required.

This project will realize the following annual savings:

MONETARY: $306,693.
AMORTIZATION PERIOD: 6.3 Years
SAVINGS PER $1000 ($\frac{E}{C}$): 34.6
BENEFIT/COST RATIO: 2.2

TOTAL ENERGY: 67,180 MBTU
ELECTRICITY: (-)219,047 KWH
NATURAL GAS: 65,175 KCF

DD FORM 1391

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Page No. 1

3442 Central Heating Plant Addition Project No. B408-T497

1. GENERAL. This Project is oriented toward curtailing the use of energy by the construction of a Central Heating Plant to replace multiple plants now serving 24 buildings. System to include diversity and provide more efficient operation and maintenance. Natural gas as a fuel is to be supplemented with #2 fuel oil with this project.

2. ACCOMMODATIONS NOW IN USE.

Bldg. No.	Type Const	Use	Gross SF
2470	P	EM Barracks w/Mess	40,160
2471	P	EM Barracks w/Mess	40,160
3411	P	EM Barracks w/Mess	36,569
3412	P	EM Barracks w/o Mess	36,569
3413	P	EM Barracks w/Mess	36,569
3414	P	EM Barracks w/o Mess	36,569
3415	P	EM Barracks w/Mess	36,569
3416	P	EM Barracks w/o Mess	36,569
3417	P	EM Barracks w/Mess	36,569
3418	P	EM Barracks w/o Mess	36,569
3419	P	EM Barracks w/Mess	36,569
3420	P	EM Barracks w/o Mess	36,569
3421	P	EM Barracks w/o Mess	36,569
3422	P	EM Barracks w/Mess	36,569
3423	P	EM Barracks w/o Mess	36,569
3424	P	EM Barracks w/Mess	36,569
3425	P	EM Barracks w/o Mess	36,569
3426	P	EM Barracks w/Mess	36,569
3427	P	EM Barracks w/o Mess	36,569
3428	P	EM Barracks w/Mess	36,569
3429	P	EM Barracks w/o Mess	36,569
3430	P	EM Barracks w/Mess	36,569
3440	P	EM Barracks w/Mess	36,569
3444	P	Gymnasium	20,339

3. ANALYSIS OF DEFICIENCY. The exisiting 23 barracks and gymnasium were constructed in 1954 with individual heating boilers. The economic life of boilers is approaching the end of the long term investment. Furthermore, the boilers were designed for high pressure steam, but were converted to low pressure shortly after installation resulting in lowered efficiencies. The DFAE personnel are required to make numerous trips to these buildings to repair or replace worn out parts and the expense of boiler repairs is becoming prohibitive. These boilers are not water-treated at the present time. The installation of a new Central Heating Plant will save a considerable amount of energy as well as maintenance dollars. It will provide greater thermal efficiencies by way of new equipment and diversification of loads; and it will centralize operation and maintenance to a more efficient status. The present cost of visiting 24 different plants will be greatly reduced.

4. CONSIDERATION OF ALTERNATE FACILITIES & LOCATIONS.

Not applicable.

5. CRITERIA OF PROPOSED CONSTRUCTION. The proposed Facility will consist of 3 High Temperature Hot Water Boilers and pumps to circulate through a direct-bury piping system essentially paralleling an existing (but recent installation) chilled water circuit. Also to include the removal of 48 existing boilers in 24 buildings. Emissions from new boiler plant will be less than existing due to more efficient firing of boilers. Present boilers are natural gas-fired. The proposed facility will utilize #2 fuel oil as a back-up to new gas-fired boilers.

6. PROGRAMS FOR RELATED FURNISHINGS & EQUIPMENT. Equipment intended for installation is to be procured with a portion of the total funds requested.

7. DISPOSAL OF PRESENT ASSETS. Existing controls, heat-exchangers, pumps, etc. that cannot be adapted to the proposed system will be excessed as defined by the Architect-Engineer who designs the system.

8. SURVIVAL MEASURES.

Not applicable.

9. ENVIRONMENTAL IMPACT. This proposed project has favorable environmental impact as it will conserve natural resources. This project is not deemed a major action significantly affecting the human environment nor is it controversial. Therefore, an environmental impact statement pursuant to Public Law 91-190 is not required.

10. EVALUATION OF FLOOD HAZARDS.

Not applicable.

11. ECONOMIC SAVINGS. An economic analysis is attached herewith. It shows an amortization period of 6.3 years. Savings include fuel reduction and less equipment maintenance cost.

12. UTILITIES SUPPORT. this project is designed to reduce utilities, therefore no additional utilities support will be required for this project.

13. PROTECTION OF CULTURAL ENVIRONMENT. This project has no impact on any designated historical place.

14. PROJECT DEVELOPMENT BROCHURE. The Project Development Brochure Part 1, has been prepared for this project.

15. ENERGY REQUIREMENTS.

a. Project Description. The proposed Central Heating Plant is an addition to an existing Chilled Water Central Plant & will include new dual fuel boilers & central pumping of high temperature hot water to 24 existing buildings. Existing steam heating boilers will be removed and heat exchangers will be installed to convert HTHW to steam. Secondary pumping will not be required; however existing steam condensate pumps to be refurbished and reused. New controls will be required.

b. Estimated Energy Consumption.

(1). These are existing facilities with individual heating plants. This proposed project will reduce energy use as follows:

(2). Energy used for heating will be reduced by use of equipment at maximum efficiencies and through diversification of loads.

(3). Hot water services will be maintained at minimum temperatures required.

(4). Electrical power will be increased minimally (219047 kWH/Yr.) in pumping, boiler equipment and lighting to produce fuel savings.

(5). Sewerage system will be centeralized to reduce overall usage of existing facilities.

c. Energy Sources.

(1). Heating is presently generated from natural gas in existing 24 plants. These plants are 25 years old and are in fair condition. By installing larger equipment in the new proposed facility, consumption of fossil fuel, in general, would be dramatically reduced.

(2). Electrical power is provided by contract and is within present system capability.

(3). Water supply is provided by City of Lawton and will not increase.

(4). Sewerage system is Government owned and overall requirements will not change.

d. Energy Use Impacts. This is an energy conservation project, therefore it will have a favorable impact.

e. Energy Conservation. This project will reduce the annual natural gas consumption approximately 65 MCF/Year.

f. Energy Alternatives. This is a modification project to existing systems to conserve energy sources. Although and alternate fuel back-up could be coal in lieu of fuel-oil an economic comparison has been made and found to be not advantageous. Also the present site does not lend itself readily to coal storage.

g. Energy Effects-Environmental Effects. This project has no environmental effects from energy systems intended.

16. PROVISIONS FOR HANDICAPPED. In accordance with PL90-480, no provision for the handicapped will be made in the project since, in the foreseeable future, the facility will be used and operated solely by able-bodied personnel.

Jack L. Van Pool
JACK L. VAN POOL
Colonel, FA
Deputy Installation Commander

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BUDGETARY ESTIMATE DATA

Anticipated Construction Start Date: Apr 1982
Anticipated Construction Completion Date: Apr 1983
Anticipated Midpoint of Construction Date: Oct 1982
Construction Cost Index for Anticipated Midpoint of Construction Date: 2158

Fort Sill, Oklahoma FY 1982 17 Nov 1979
Project No. B408-T497
Description: 3442 Central Heating Plant Addition (ECIP)

	Quantity	Unit	Unit Cost	Total ($000)
1. Primary Facility				
a. Central Plant Bldg. Addition	4,600	SF	51.47	237.
($41. x 2158 ÷ 1719 = $51.47)				
b. Boilers & Associated Equipment	3	Ea.	LS	1,183.
c. HTHW Pumps	3	Ea.	LS	8.
2. Supporting Facility				
a. Heating Water Piping Distribution	12,140	LF	23.55	286.
b. Retrofit Existing Bldgs.	24	Ea.	LS	79.
c. Electrical Work			LS	20.
d. Site Work			LS	30.
e. Fuel Storage Tanks	2	Ea.	15,000	30.
f. Recording Instruments, Meters, Controls			LS	62.
g. Gas Service To New C. H. P.			LS	6.
TOTAL ESTIMATED COST				1,941.

ECONOMIC ANALYSIS (ECIP)

Location: Fort Sill, Oklahoma FY 1982

Project: 3442 Central Heating Plant Addition

Project No. B408-T497

Economic Life 25 Yrs. Date Prepared 17 Nov 1979 Prepared By C.Robert Scruggs

COSTS

1. Non-recurring Initial Capital Costs.

a. CWE	$ 1,941,100.		
b. Design	$ 104,641.		
c. Salvage	$ 1,512.	(-)	
d. Total			$ 2,044,229.

BENEFITS

2. Recurring Benefit/Cost Differential Other Than Energy

a. Annual Labor Decrease (+)/ Increase (-)	$ 136,390. /Yr.	(+)	
b. Annual Material Decrease (+)/ Increase (-)	$ 27,786. /Yr.	(+)	
c. Other Annual Decrease (+) /Increase (-)	$ - /Yr.		
d. Total Costs	$ 164,176. /Yr.	(+)	
e. 10% Discount Factor	9.524		
f. Discounted Recurring Cost (d x e)			$ 1,563,612. (+)

3. Recurring Energy Benefit/Costs

a. Type of Fuel Electricity

(1) Annual Energy Decrease (+)/ Increase (-)	1,906. MBTU	(-)
(2) Cost per MBTU	$ 2.07 /MBTU	
(3) Annual Dollar Decrease/Increase ((1)x(2))	$ 3,945. /Yr.	(-)
(4) Differential Escalation Rate (7 %) Factor	18.049	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	$ 71,203.	(-)

b. Type of Fuel Electric Demand

(1) Annual Energy Decrease (+)/ Increase (-)	N/A MBTU	
(2) Cost per MBTU	$ - /MBTU	
(3) Annual Dollar Decrease/Increase ((1)x(2))	$ - /Yr.	
(4) Differential Escalation Rate (7 %) Factor	-	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	$ -	

c. Type of Fuel Natural Gas

(1) Annual Energy Decrease (+)/ Increase (-)	69,086. MBTU	(+)
(2) Cost per MBTU	$ 2.12 MBTU	
(3) Annual Dollar Decrease/Increase ((1)x(2))	$ 146,462. /Yr.	(+)
(4) Differential Escalation Rate (8 %) Factor	20.050	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	$ 2,936,563.	(+)

d. Type of Fuel -

(1) Annual Energy Decrease (+)/ Increase (-)	- MBTU
(2) Cost per MBTU	$ - MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	$ - /Yr.
(4) Differential Escalation Rate (%)	-
(5) Discounted Dollar Decrease/Increase ((3x(4))	$ -

e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)	$ 2,865,360.
4. Total Benefits (Sum 2.f + 3e)	$ 4,428,972.
5. Discounted Benefit/Cost Ratio (Line 4 ÷ Line 1d)	2.2
6. Total Annual Energy Savings 3a(1)+3b(1)+3c(1)+3d(1)	67,180. MBTU
7. E/C Ratio (Line 6 ÷ (Line 1a/1,000))	34.6
8. Annual $ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3)	$ 306,693.
9. Payback Period ((Line 1a - Salvage) ÷ Line 8	6.3 YEAR

ECONOMIC ANALYSIS (CONT.)

1. Non-recurring Initial Capital Costs:

Construction		\$ 1,443,822.
SIOH @ 5 %		\$ 72,191.
Unescalated CWE		\$ 1,516,013.
CWE (Escalated to End FY 82):		
\$ 1516013 x 1.07 x 1.065 x 1.06 x 1.06 (Entered on Line 1.a.)	=	\$ 1,941,100.
Unescalated Design @ 6 % of Construction:		
.06 x \$ 1,443,822.	=	\$ 86,629.
Design (Escalated to End FY 81):		
\$ 86,629. x 1.07 x 1.065 x 1.06 x – (Entered on Line 1.b.)	=	\$ 104,641.
Salvaged value of removed equipment:	=	\$ 1,200.
Salvage value (Escalated to End FY 82):		
\$ 1,200. x 1.064 x 1.062 x 1.056 x 1.056 (Entered on Line 1.c.)	=	\$ 1,512.

2. Recurring Benefit (+)/Cost (–) Differential Other Than Energy:

Labor (Unescalated)	=	\$ 108,240. ( )
Labor (Escalated to End FY 82)		
\$ 108,240. x 1.064 x 1.062 x 1.056 x 1.056 (Entered on Line 2.a.)	=	\$ 136,390. (+)
Materials (Unescalated)	=	\$ 22,051. ( )
Materials (Escalated to End FY 82):		
\$ 22,051. x 1.064 x 1.062 x 1.056 x 1.056 (Entered on Line 2.b.)	=	\$ 27,786. (+)

3. Recurring Energy Benefits (+)/Costs (–):

a. Electric Energy: ((–)219,047.KWH x 8700 BTU/KWH)

$\bar{M}$BTU Saved (Entered on Line 3.a.(1).)	=	1,906. (–) $\bar{M}$BTU
\$ Cost/$\bar{M}$BTU	=	\$ 1.207 /$\bar{M}$BTU
\$ Cost/$\bar{M}$BTU (Escalated to End FY 82):		
\$ 1.207 x 1.16 x 1.16 x 1.13 x 1.13 (Entered on Line 3.2.(2).)	=	\$ 2.07 /$\bar{M}$BTU

b. Demand Charge Reduction:

$\bar{M}$BTU Saved:		Negligible
Annual Dollar Saving	=	\$ – /Yr.
Annual Dollar Saving (Escalated to End FY 82):		
\$ – x 1.16 x 1.16 x 1.13 x 1.13 (Entered on Line 3.b.(3).)	=	\$ –

c. Natural Gas: (65.175 $\bar{M}$CF x 1060 BTU/CF)

$\bar{M}$BTU Saved (Entered on Line 3.c.(1).)	=	69,086. $\bar{M}$BTU
\$ Cost/$\bar{M}$BTU	=	\$ 1.231 /$\bar{M}$BTU
\$ Cost/$\bar{M}$BTU (Escalated to End FY 82):		
\$ 1.231 x 1.15 x 1.15 x 1.14 x 1.14 (Entered on Line 3.c.(2).)	=	\$ 2.12 /$\bar{M}$BTU

ABBREVIATIONS	DENOTATION
K	KILO (10^3)
$\bar{M}$	MEGA (10^6)
KBH	1000 BTU/HR.
$\bar{M}$BH	MEGA BTU/HR.
$\bar{M}$BTU/YR. (or $\bar{M}$BU/YR)	MEGA BTU/YEAR
CF	CUBIC FEET
GAL	GALLON
KWH	KILO WATT HOURS

FUEL	COST OF FUEL @ FT.SILL	COST OF FUEL @ SOURCE	REMARKS
NATURAL GAS (JAN '78)	\$1.305/KCF	\$1.231/$\bar{M}$BU	RE: ARKLA GAS COMPANY @ 1060 BTU/CF.
FUEL OIL #2 (JUL '78)	\$0.3789/GAL	\$2.732/$\bar{M}$BU	RE: KERR-McGEE COMPANY *1 DISTIL. F.O. @ 138,700 BTU/GAL.
COAL (APR '78)	\$40.75/TON	\$1.658/$\bar{M}$BU	RE: ASSOCIATED PRODUCERS COMPANY @ 13,478 BTU/LB OR 26.956 $\bar{M}$BU/TON *1 USE: 24.58 $\bar{M}$BU/TON
ELECTRICITY (SEPT '78) ENERGY CHARGES			RE: PUBLIC SERVICE CO. OF OKLA. & SWPA 25% HYDRO-ELEC. @ \$0.002/KWH TO 4.877 $\bar{M}$KWH + \$0.003/KWH ALL OVER 4.877 $\bar{M}$KWH 75% FOSSIL FUEL @ \$0.01338/KWH: 25% @ \$0.002 = \$0.0005 75% @ \$0.01338 = \$0.0100
	\$0.0105/KWH		\$0.0105/KWH
			\$0.0105/KWH (75% x 11,600 BTU/KWH *2) + (25% x 0 BTU/KWH (HYDRO-ELEC.) =
		\$1.207/$\bar{M}$BU	\$0.0105 x 8700 = \$1.207/$\bar{M}$BU (@ SOURCE) FROM 8700 BTU/KWH TO 3414 BTU/KWH (@ FT.SILL):
	\$3.076/$\bar{M}$BU		2.548 x \$1.207 = \$3.076/$\bar{M}$BU (@ FT. SILL)
DEMAND CHARGES	\$1.60/KW		RE: PUBLIC SERVICE CO. OF OKLA. MINIMUM MONTHLY CHARGE BASED ON 32,500 KW x \$1.60 = \$52,000

*1 RE: ECIP

*2 For this report, we have taken the recommended 11,600 BTU/KWH as given by the ECIP Guidance (DAEN-FEU, 7 Nov. 1977) for Source Energy and derated it 25% or 8700 BTU/KWH because of the advantages Ft. Sill is receiving from hydroelectric generation.

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ECONOMIC ANALYSIS BACK-UP

"A" SCHEDULE OF BLDGS & LOADS

1.

Q	BUILDING	GLASS AREA S.F.(ea)	GLASS AREA S.F.(Tot)	TOT. HTG $\bar{M}$BH (ea) INSTALLED	TOT. HTG $\bar{M}$BH (ea) DESIGN	LOADS HTG $\bar{M}$BH INSTALLED	LOADS HTG $\bar{M}$BH DESIGN
21	3400 Bks	2627	55167.	2.879	1.256	60.459	26.376
2	2470-71 Bks	2902	5804.	4.800	1.610	9.600	3.220
1	3444 Gym	-	-	1.200	2.045	1.200	2.045
	TOTALS		60971. *1			71.259	31.641

2. Reduction in Load due to storm windows added:

60971 SF Glass x 40 BTU/(H)(SF) *2 = 2.439

New Total Estimated Load = 29.202 $\bar{M}$BH

3. Higher efficiencies can be maintained with new boilers in a C.E.P. than presently exists with 24 individual, older, gas-fired boilers serving 24 bldgs.

Efficiencies of boilers are taken from an average of those listed herein; reference being made to "Tuning for Maximum Efficiency" (by Elzy Nichols Industrial Gas Publication; dated April 1978). The author states: "Older boilers often have an efficiency of 70%, but for most of them 55% is tops---. Five to ten percent increase can be effected on older units by repairing, cleaning & closing up cracks and holes, but they cannot be brought to the level of a new boiler."

In our judgement from field survey of these facilities, most boilers are of the older type. There are some that have been renovated w/controls, refractories, linkages, etc., which would increase these efficiencies to that refered above if they were maintained properly.

For this study the average, maintained, peak efficiency is conservatively estimated at 60% for existing boilers.

4. 71.259 $\bar{M}$BH x 0.60 = 42.755 $\bar{M}$BH (Exist.)

5. Boiler Oversizing to Loads:

$$\frac{42.755\ \bar{M} - 29.202\ \bar{M}}{29.202\ \bar{M}} = 46.4\%\ \text{Oversized}$$

6. $$E = \left[\frac{29.202\ \bar{M}BH \times 2899\ DD \times 24\ Hrs}{52^{o}F \times 0.60}\right] (.85)\ (1.89)\ ^{*3} = 104,620.\ \bar{M}BTU/Yr.$$

With higher efficiencies from new boilers & matching boilers to Load:

$$E = \left[\frac{29.202\ \bar{M}BH \times 2899 \times 24}{52^{o}F \times .70\ ^{*4}}\right](.85)\ (1.36) = 56,459.\ \bar{M}BTU/Yr.$$

TOTAL E Htg Saved = 48,161. $\bar{M}$BTU/Yr.

*4 Re: International Boiler Co. Efficiencies
*3 Re: ASHRAE '76, S-43.8 TAB 3 (By Interpolation)
*2 Re: Calculations, (page 10 & 11
*1 Glass Area for Bldgs w/Storm Windows added in FY '79.

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"B" Higher efficiencies for domestic hot water can be maintained with new boilers in a C.E.P. than presently exists. (Ref. to comments in "A" above).

Consumption Estimate

Domestic HW ($140^{O}F$):

21 Bks @ 190 peop/Bldg + (2 Bks @ 210)	= 4,410 people	
4,410 peop x 3.8 GPH/person (Max) *1	= 16.758 GPH	
16,758 GPH x 8.33 x 80^{O}Rise	= 11.168 $\bar{M}$BH Demand	
4,410 x 13.1 GPD/person *1 x 365 day/yr	= 21.086 $\bar{M}$ Gal/ Yr	
21.086 $\bar{M}$ x 8.33 x (140^{O} - 60^{O})		= 14,052. $\bar{M}$BTU/Yr

Kitchen HW ($140^{O}F$):

4,410 peop x 2.5 meals/day (Av'g) x 75% Div.	= 8,269. meals/day Av'g.	
8,269 x 1.5 GPH/meal (Max) *1	=12,404. GPH (Max)	
12,404. GPH x 8.33 x 80^{O} Rise	= 8.266 $\bar{M}$BH Demand	
8,269 meals/day x 2.4 GPD/Av'g meal *1	=19,846. GPD ($140^{O}F$)	
19,846 x 300 Days/Yr	= 5.953 $\bar{M}$ Gal/Yr	
5.953 $\bar{M}$ x 8.33 x 80^{O}		= 3,968. $\bar{M}$BTU/Yr

Kitchen HW ($180^{O}F$) ($140^{O}F$ HW Boosted $40^{O}F$)

1.31 *2 x 12,404. GPH Max.	= 16,249. GPH (180^{O}HW)	
16,249 x 8.33 x 40^{O} Rise	= 5.414 $\bar{M}$BH (Demand 180^{O})	
1.31 x 5.953 $\bar{M}$ Gal/Yr (140^{O})	= 7.798 $\bar{M}$ Gal/Yr (180^{O})	
7.798 $\bar{M}$ x 8.33 x 40^{O}		= 2,598. $\bar{M}$BTU/Yr
Total Estimated Dom. & Kitchen Consumption		= 20,618. $\bar{M}$BTU/Yr
E Dom. & Kit. = $\frac{20,618.\ \bar{M}BTU/Yr}{.60}$		= 34,363. $\bar{M}$BTU/Yr
w/C.E.P. Boiler Efficiency @ 80%		= 25,773. $\bar{M}$BTU/Yr
Total Dom. & Kit. HW Saved		= 8,590. $\bar{M}$BTU/Yr

*2 Re: ASHRAE '76 S-37.18 - Example Problem #6.

*1 Re: ASHRAE '76 S-37.11 (TAB 6)

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"C" Diversity of Loads & Boiler Operation From C.E.P:

Boiler Selection:

From "A" :	Heating Connected Load	=	29.202 M̄BH
From "B" :	Domestic Brks (140^{o}F)	=	11.168 M̄BH
	Kitchen (140^{o}F)	=	8.266 M̄BH
	Kitchen (180^{o}F)	=	5.414 M̄BH
Total Existing Estimated Connected Load		=	54.050 M̄BH
	@ 85% Diversity	=	45.943 M̄BH
	@ 10% Pipe Loss	=	4.594 M̄BH
	New C.E.P. Loss	=	.400 M̄BH
New Total Estimated Demand		=	50.937 M̄BH (Max. Winter Design Load)

Winter Max. @ 75% Load for all but one Boiler *1	=	38.202 M̄BH
Winter Min. @ 65% Load for all but one Boiler	=	33.109 M̄BH
Summer Min.	=	24.848 M̄BH

Try: 3 Ea. Gas/oil-fired HTHW Boilers @ 20 M̄BH

Diversity of Loads:

E (New Htg. Consumption from "A")	=	56,459. M̄BTU/Yr.
E (New Dom. Consumption from "B")	=	25,773. M̄BTU/Yr.
E TOTAL	=	82,232. M̄BTU/Yr.
@ 85% Diversity	=	69,897. M̄BTU/Yr.
E TOTAL SAVED	=	12,335. M̄BTU/Yr.

*1 Re: ETL 1110-3-256, 28 Sep '76

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"D" Labor and Material Recurring Costs/Yr.

	$/YEAR SAVED (+)	COSTS (-)
1. Maintaining 24 Existing Boiler Plants:		
4 MD/Boiler/Yr. x 48 = 192 MD		
1/2 MD/pump x 48 x 12 Mos/Yr. = 288 MD		
Operating 48 Boilers:		
1/2 MD/Boiler/Wk. *1 x 48 x 52 Wks.= 1248 MD		
TOTAL: @ $80/Day x 1728 MD =	$138,240.(L)	
2. Equipment and Materials:		
Replacement of Exist. Boilers for Equiv. Life:		
$10,000/Boiler x 48 = 480,000/25 Yr. =	19,200.(M)	
$ 350/pump x 48 = 16,800/25 Yr. =	672.(M)	
3. Truck Expense: @ $10,000/7 Yrs. =	1,429.(M)	
@ 10¢/Mi. x 7500 Mi/Yr. =	750.(M)	
4. Operation and Maintanence of New C.E.P.		
1 man x 24 Hrs./Day x 365 Days/Yr. x $10/Hr. =		(-) 87,600.(L)
5. Tuning Boilers: 48 Boilers in 24 Plants to be tuned and tested periodically to maintain high effic's. as compared to 3 new boilers:		
Repair and Adjust controls Ea. Boiler - 2 MD		
Test Firing and Cleaning Burners 2 MD		
Clean & Adj. Dampers/Motors/Linkage 2 MD		
CO_2 Testing 2 MD		
Twice Ea. Year: 2 x (48-3)ea.x $80/Day x 8 MD =	57,600.(L)	
TOTAL LABOR:	$195,840.	(-) 87,600.
TOTAL MATERIAL:	$ 22,051.	-
NET LABOR SAVED:	$108,240.	
NET MATERIAL SAVED:	$ 22,051.	

*1 AR420-49 18 Nov 76, Tab 2-1: Operational Visits.

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1. Retrofit:

Remove 48 exist. Boilers and Water Heaters	LS =	24,000.
3 HTHW Heat - X's x 24 Bldgs. x $350/Ea.	=	$25,200.
Piping @ 24 x $250/Ea.	=	6,000.
Insulation @ 24 x $200/Ea.	=	4,800.
Controls @ 24 x $350/Ea.	=	8,400.
Electrical @ 24 x $150/Ea.	=	3,600.
Misc.	=	7,200.
TOTAL:		$79,200.

2. Salvage:

Controls in 24 Bldgs. @ $50/Ea.	=	$ 1,200.
Boilers		-0-
TOTAL:	=	$ 1,200.

"F" Energy expended in new (proposed) C.E.P. by new gas/oil-fired boiler motor accessories as compared to 24 individual plants presently operating.

ENERGY EXPENDED (KWH/Yr.)

1. Proposed boiler (3 ea. @ 20 $\overline{M}$BH ea):

Forced draft blower motor @ 7.5 Hp ea:

7.5 Hp/boiler x 0.746 KW/Hp = 5.60 KW/20$\overline{M}$BH. Boiler
or 3.58 $\overline{M}$BTU/ KWH

$$E\ (\text{Add'l}) = \frac{69{,}897.\ \overline{M}\text{BTU/Yr.}}{3.58\ \overline{M}\text{BTU/ KWH}} =$$ 19,524.

2. Proposed pumping vs. Existing:

Distribution pumping (from FY '82 C.E.P.):

$$\text{GPM} = \frac{54.050\ \overline{M}\text{BH}}{500 \times (380^{\circ} - 280^{\circ})} = 1081\ \text{GPM}$$

$$\text{HP} = \frac{1081\ \text{GPM} \times 100'\ \text{HD}}{3960 \times 0.60\ (\text{eff.})} = 46\ \text{bHp} \times 0.746\ \text{KW/Hp} = 34\ \text{KW}$$

E (Add'l) = 34 KW x 8760 Hrs./Yr. x 0.67 (Divers.) = 199,523.

ADDITIONAL ESTIMATED ELECTRICAL CONSUMPTION 219,047.

$\sum$ ENERGY SAVINGS/YEAR (RE: ECIP ECONOMIC ANALYSIS)

METHOD	TOTAL SOURCE ENERGY SAVED MBTU	TOTAL FUEL SAVED ELECTRIC KWH	TOTAL FUEL SAVED NAT.GAS MBTU	RECURRING COSTS SAVED *1	OTHER COSTS (INITIAL)	DESCRIPTION OF COST SAVINGS METHOD
"A"	48,161.	–	48,161.	–	–	Higher Efficiencies (HTG)
"B"	8,590.	–	8,590.	–	–	Higher Efficiencies (DOM.)
"C"	12,335.	–	12,335.	–	–	C.E.P. HTG. Water Diversity
"D"	–	–	–	$108,240.	–	Labor Saved
	–	–	–	22,051.	–	Material Saved
"E"	–	–	–	–	(–) $79,200.	Retrofit Costs
					(+) 1,200.	Salvage Costs
"F"	(–) 1,906.	(–) 219,047.	–	–	–	Energy Expended W/New C.E.P. Facility
TOTALS:	67,180.	(–)219,047. ((–) 1,906. MBTU/Yr.)	69,086. (65,175. MCF/Yr)	$130,291.	(–) $78,000.	

*1 Other Than Energy

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ALTERNATE FUEL COMPARISONS (PER AR420-49, 18 NOV 76, TAB 3-1)

	GAS	OIL	COAL *1
C.W.E. (UNESCALATED)	1,443,822.	1,443,822.	2,240,822.
SAVINGS OVER EXISTING:			
E (M̄BTU/YR)	69,086.	59,101.	64,427.
GAS @ $1.231/M̄BTU *2	$85,045.	$75,753.	$79,310.
RECURRING COSTS/YR SAVED OVER EXIST:			
LABOR	$108,240.	$108,240.	$20,640.
MATERIAL	$22,051.	$22,051.	$19,872.
INCREASED ELECTRICAL OVER EXISTING:			
E (KWH/YR)	219,047.	219,047.	246,651.
E (M̄BTU/YR)	(-)1,906.	(-)1,906.	(-)2,146.
ELECTRICAL COST/YEAR	(-)$2,300.	(-)$2,300.	(-)$2,590.
TOTAL E CONSUMPTION WITH C.H.P. (M̄BTU/YR)	69,897. @ $1.231/M̄BTU	79,882. @ $2.732/M̄BTU	74,556. @ $1.658/M̄BTU
COSTS/YEAR (ABOVE LEAST EXPENSIVE FUEL AS A BASE)	(86,043.) -0-	(218,238.) (-)132,194.	(123,614.) (-)37,571.
NET COMPARATIVE COST SAVINGS/YR.	$213,036.	$71,550.	$79,661.
NET E SAVED (M̄BTU/YEAR)	67,180.	57,195.	62,281.
SIMPLE PAY-BACK	6.7	20.2	28.1

*2 RE: Rate Schedule, Page 1 of 13

*1 RE: Page 9 of 13

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COAL FIRED BOILERS - COMPARATIVE ESTIMATES

1. Total cost (Unescalated from ECIP, Economic Analysis) = $1,443,822.

Coal Fired Boilers, Additional Cost

a. Central Plant Addition	4600 SF	10.	46,000.	
b. Coal & Ash Handling Equipment		LS	300,000.	
c. Deduct Fuel-Oil Storage Tanks		LS	(-) 30,000.	
d. Rail Spur		LS	300,000.	
e. Site Preparation		LS	50,000.	
f. Scrubbers & Filters		LS	41,000.	
g. Boilers		LS	90,000.	
TOTAL ADDITIONAL COST =				$ 797,000.
TOTAL COST =				$2,240,822.

2. REF. TO "A" HEREIN :

E with Oil Fired Boilers @ 70% = 64,525. $\overline{M}$BTU/YR, savings = 40,095. $\overline{M}$BTU/YR.
E with Coal Fired Boilers @ 75% = 60,223. $\overline{M}$BTU/YR, savings = 44,397. $\overline{M}$BTU/YR.

3. REF. TO "B" HEREIN :

(with Oil Fired Boilers Eff. @ 70% = 29,454. $\overline{M}$BTU/YR, savings = 4,909. $\overline{M}$BTU/YR)
(with Coal Fired Boilers Eff. @ 75% = 27,490. $\overline{M}$BTU/YR, savings = 6,873. $\overline{M}$BTU/YR)

4. REF. TO "C" HEREIN :

		OIL	COAL
E (Heating from "A")	=	64,525.	60,223.
E (Domestic from "B")	=	29,454.	27,490.
E Totals $\overline{M}$BTU/YR.	=	93,979.	87,713.
@ 85% Diversity	=	79,882.	74,556.
E Saved, Total $\overline{M}$BTU/YEAR	=	14,097.	13,157.

5. REF. TO "D" HEREIN :

For Coal Fired Boilers - (Supplement above "D" with the following:

1. Assume Coal & ash handling vehicle expense to balance out with truck expense.		(-) 1,429.(M) (-) 750.(M)
2. Additional Labor (Coal & Ash Handling) 3 men @ 8 Hrs/Day x 365 days/Yr x $10/Hr.		(-) 87,600.(L)
TOTAL LABOR:	$195,840.	(-)$175,200.
TOTAL MATERIAL:	$ 22,051.	(-)$ 2,179.
NET LABOR SAVED:	$ 20,640.	
NET MATERIAL SAVED:	$ 19,872.	

6. REF. TO "F" HEREIN :
For Coal Fired Boilers - (Supplement above "F" with the following:

Coal Stoker forced draft blower	10 Hp
Coal Stoker overfire air blower	7.5 Hp
Coal Stoker hydraulic drive	5 Hp

@ 0.746 KW / Hp X 22½ Hp = 16.8 KW/20 $\overline{M}$BH Boiler or 1.19 $\overline{M}$BTU/KWH

$$E = \frac{74{,}556\ \overline{M}BTU/YR}{1.19\ \overline{M}BTU/KWH} = 62{,}652.\ KWH/YR = (19{,}524.\ \overline{M}BTU/YR) = 43{,}128\ (Additional)$$

199,523 (Pumping)
242,651

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Infiltration Calculations for Storm Windows Added:

Select existing Prime & New Storm Windows for the Basis of this study as follows:

WINDOW	PRIME	STORM
Material	Wood	Alum.
Type	Double Hung	Single Hung
Weatherstripped	Loose Fit	Regular Fit
Size	3'x4' = 12 SF	3'x4' = 12 SF
Crack	17 L.F.	17 L.F.

Winter Infiltration @ 15 mph wind velocity or .1" H_2O DP

Summer Infiltration @ 7½ mph wind velocity or .025" H_2O DP

*1 Winter: 0.5 CFM/LF x 17 LF = 8.5 CFM/Window x .6 = 5.1 CFM/Window

*2 Summer: 0.25 CFM/LF x 17 LF = 4.3 CFM/Window x .6 = 2.6 CFM/Window

@ ½ Glass Area for Infiltration:

Factors for Infiltration Reduction:

Winter: $\frac{(8.5 - 5.1) \text{ CFM/Window}}{12 \text{ SF}} \times \frac{1}{2}$ = .14 CFM/SF glass

Summer: $\frac{4.3 - 2.6}{12} \times \frac{1}{2}$ = .07 CFM/SF

Load Reduction by Infiltration:

HTG: .14 CFM/SF x 1.08 x 52°F = 7.9 BTU/(H)(SF)

CLG: $\begin{bmatrix} (.07 \times 1.08 \times 22^\circ\text{F}) + \\ (.07 \times 4840 \times .0036\#/\#\text{Dry Air}) \end{bmatrix}$ = 2.9 BTU/(H)(SF)

Load Reduction by Adding Storm Glass

Transmission & Solar:*1

Summer:

Single Flat Glass: U = 1. w/o Shade

U = 0.81 w/Indoor Shade

Glass Shading Coef = 1.0

Indoor Shade (Blinds)*2 Coef = 0.55

Transmission: H = UA (CLTD)

*3 Clear Glass w/Light colored venetian blinds

*2 ASHRAE '77 F 25.14

*1 For both Prime & Storm:
ASHRAE Heating/Cooling Load Calculation Manual, Grp 158, Figs 5.11 & 5.12

SOLAR: $H = A (SC)(SHG)(CLF)$

MAX. SHG for August, 32^{o} LAT.

		TRANSMISSION		SOLAR										AVERAGE		TRANSM. PLUS SOLAR
				SOUTH			EAST/WEST			NORTH						
	TIME	CLTD	U	(SHG)	(CLF)	= F	(SHG)	(CLF)	= F	(SHG)	(CLF)	= F	F	(SC)	BTU (H) (SF)
SINGLE	1400	13	.81	111.	.71	79.	219.	.53	116.	37.	.88	33.	76	.55	
GLASS	1600	14	.81	111.	.37	41.	219.	.83	182.	37.	.77	28.	84	.55	11. + 46. = 57.
	1800	12	.81	111.	.20	22.	219.	.63	138.	37.	.92	34.	65	.55	
DOUBLE GLASS or STORM WINDOWS	1600	14	.52										84	.51	7. + 43. = 50.

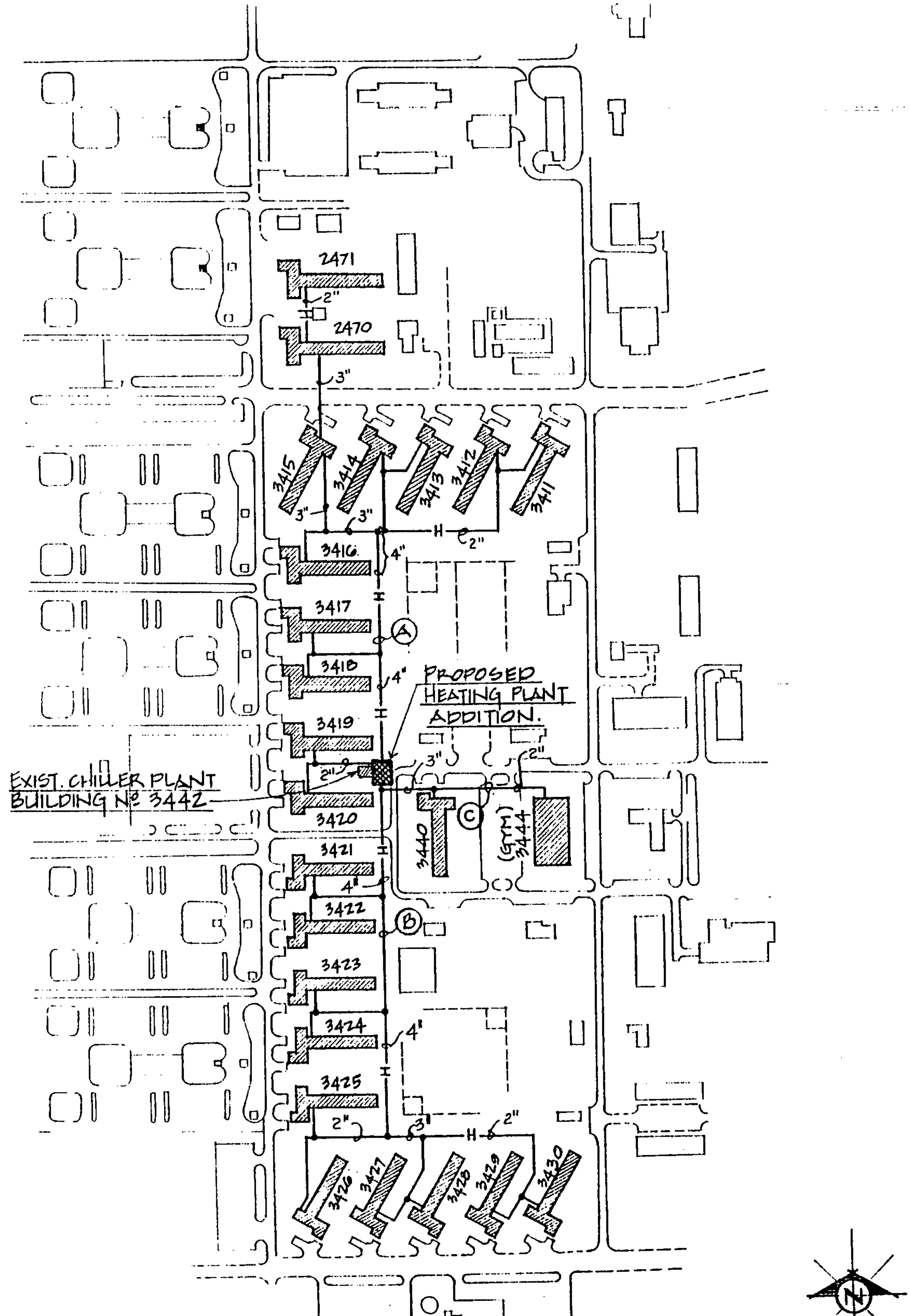
SUMMER: Total Transmission & Solar Reduction = 57 - 50 = 7. BTU/(H)(SF)

WINTER: Total Transmission = (1.1 - .49) (52^{o}F) =32. BTU/(H)(SF)

Total Reduction by adding Storm Windows including Transmission, Solar, & Infiltration:

WINTER: 7.9 + 32. = 39.9 or 40. BTU/(H)(SF)

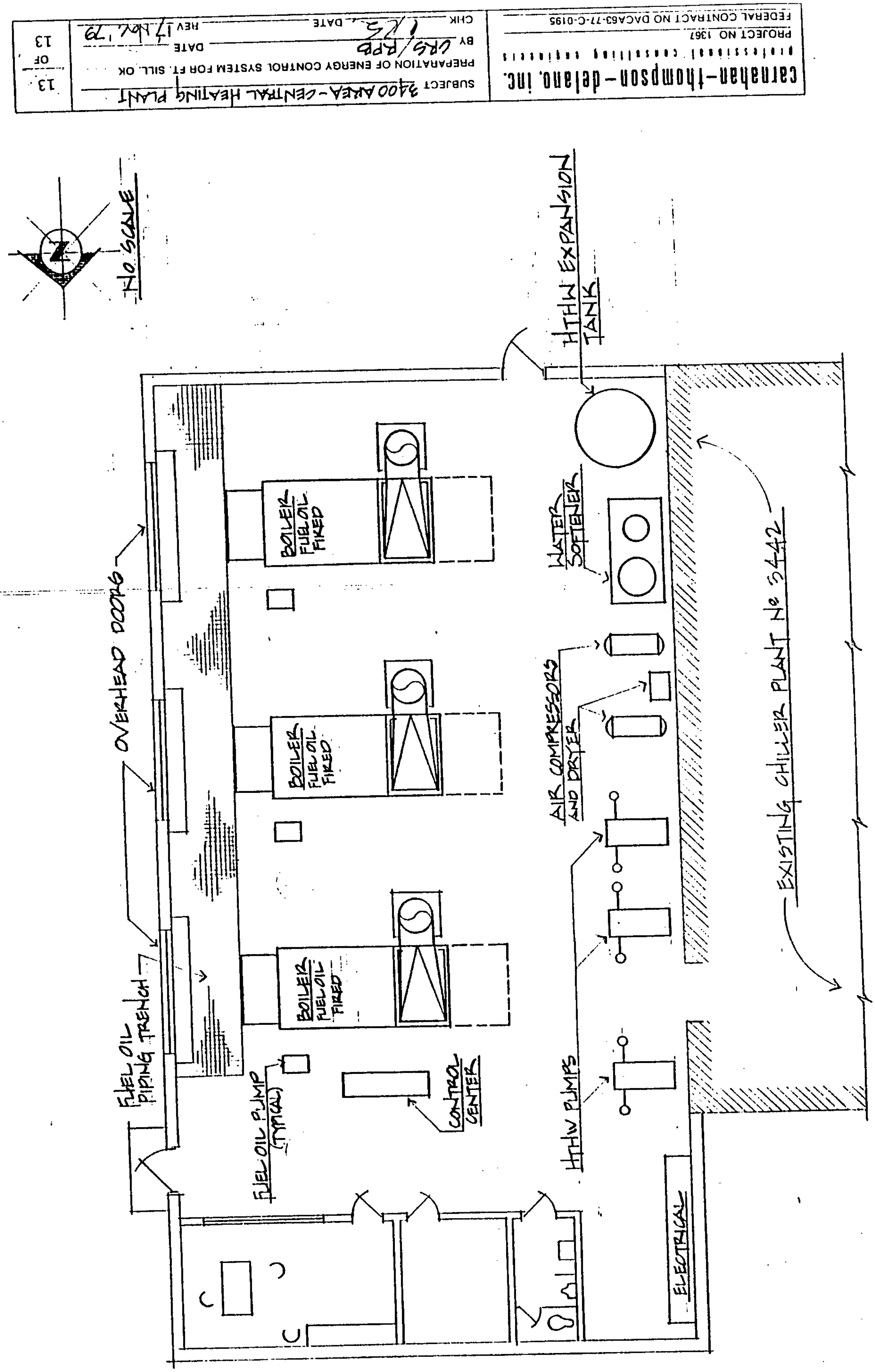
SUMMER: 2.9 + 7. = 9.9 or 10. BTU/(H)(SF)



—H— Hi-TEMP. HOT WATER SUPPLY AND RETURN LINES. (PROPOSED).

PLAN VIEW - NO SCALE

..rnahan-thompson-delano, inc. professional consulting engineers PROJECT NO. 1367 3442 C.H.P. FEDERAL CONTRACT NO DACA63-77-C-0195	SUBJECT 3400 AREA - CENTRAL HEATING PLANT PREPARATION OF ENERGY CONTROL SYSTEM FOR FT. SILL, OK BY C.R.S. DATE 5 MARCH, 1979 CHK CRS DATE REV 17 NOV. '79	12 OF 13


carnahan-thompson-delano, inc.
professional consulting engineers
PROJECT NO. 1367
FEDERAL CONTRACT NO DACA63-77-C-0195
SUBJECT 3400 AREA-CENTRAL HEATING PLANT
PREPARATION OF ENERGY CONTROL SYSTEM FOR FT. SILL, OK
BY CRS/RPB DATE
CHK DATE
REV 17 NOV. 79
13 OF 13
N
NO SCALE
HTHW EXPANSION TANK
WATER SOFTENER
AIR COMPRESSORS AND DRYER
HTHW PUMPS
EXISTING CHILLER PLANT No 5442
OVERHEAD DOORS
BOILER FUEL OIL FIRED
BOILER FUEL OIL FIRED
BOILER FUEL OIL FIRED
FUEL OIL PIPING TRENCH
FUEL OIL PUMP (TYPICAL)
CONTROL CENTER
ELECTRICAL

APPENDIX H

RFD; 5900 CEP, DD1391

AR 415-17: BUILDING COST INDEX 2158

1. DATE	2. FISCAL YEAR	MILITARY CONSTRUCTION PROJECT DATA	3. DEPARTMENT	4. INSTALLATION
19 Nov 1979	1982		Army	Fort Sill

5. PROPOSED AUTHORIZATION	6. PRIOR AUTHORIZATION	7. CATEGORY CODE NUMBER	8. PROGRAM ELEMENT NUMBER	9. STATE/COUNTRY
$ 1,401,400.	P.L.	89045		Oklahoma

10. PROPOSED APPROPRIATION	11. BUDGET ACCOUNT NUMBER	12. PROJECT NUMBER	13. PROJECT TITLE	NM	CM	RM
$ 1,401,400.		B408-T498	Refuse Derived Fuel, 5900 C.E.P. (ECIP)			X

SECTION A - DESCRIPTION OF PROJECT

14. TYPE OF CONSTRUCTION	
a. PERMANENT	X
b. SEMI-PERMANENT	
c. TEMPORARY	
15. TYPE OF WORK	
a. NEW FACILITY	
b. ADDITION	X
c. ALTERATION	
d. CONVERSION	
e. OTHER (Specify)	
16. REPLACEMENT	
17. TYPE OF DESIGN	
a. STANDARD DESIGN	
b. SPECIAL DESIGN	X
c. DRAWING NO.	

18. PHYSICAL CHARACTERISTICS OF PRIMARY FACILITY

a. NO. OF BLDGS NA | b. NO. OF STORIES NA | c. LENGTH N/A | d. WIDTH N/A

e. DESIGN CAPACITY N/A | f. GROSS AREA N/A

g. COOLING CAP. COST ($)

19. DESCRIPTION OF WORK TO BE DONE Addition to Central Energy Plant Bldg. #5900 to house refuse derived fuel boiler and ash & refuse handling equipment. Addition to be similar construction to existing Bldg. with concrete floors, ash pit, masonry walls, built-up roof on steel deck & structure. Site preparation work to include concrete, drives & ramps. Boiler; ram loader; conveyors; complete with controls & accessories with all electrical work, including loaders, piping & insulation.

SECTION B - COST ESTIMATES

20. PRIMARY FACILITY	U/M	QUANTITY	UNIT COST $	COST ($000)
				$ 1,077.
a. Addition to #5900 C.E.P.	SF	7110	57.75	411.
b. Solid Waste Boilers	Ea.	1	LS	663.
c. Heating Water Pumps	Ea.	1		3.
d.				
21. SUPPORTING FACILITIES				$ 324.
a. Refuse & Ash Handling Equip.			LS	153.
b. Electrical			LS	9.
c. Piping			LS	28.
d. Site Work			LS	37.
e. Controls			LS	9.
f. Pollution Control Equip.			LS	88.
g.				
h.				
i.				
j.				
22. TOTAL PROJECT COST				$ 1,401.

SECTION C - BASIS OF REQUIREMENT

23. QUANTITATIVE DATA (U/M N/A)

	AUTHORIZED	FUNDED
a. TOTAL REQUIREMENT		
b. EXISTING SUBSTANDARD	( )	
c. EXISTING ADEQUATE		
d. FUNDED, NOT IN INVENTORY		
e. ADEQUATE ASSETS (c + d)		
f. UNFUNDED PRIOR AUTHORIZATION		
g. INCLUDED IN FY ____ PROGRAM		
h. DEFICIENCY (a - e - f - g)		

24. RELATED PROJECTS

25. REQUIREMENT FOR PROJECT This project is required to offset energy generated by existing boilers in the #5900 C.E.P. facility, thus reducing fuel-oil consumption, substantially. Present refuse hauling for Ft. Sill will be decreased by diverting same to C.E.P. where combustibles will be partially separated for incineration in boiler specifically designed for such. Refuse & ash handling facilities, including additional operators will be required. The natural environment will be greatly improved by reducing land-fill requirements from 45 tons/day to 12.6 tons/day, or 72%.

This project has been reviewed and it has been determined that an "environment impact statement" pursuant to P.L. 91-190 is not required.

This project will realize the following annual savings:

MONETARY:	$529,627.	TOTAL ENERGY:	139,547. MBTU
AMORTIZATION PERIOD:	2.7 Years	ELECTRICITY:	(-)98,024. KWH
SAVINGS PER $1000 $(\frac{E}{C})$:	99.6	FUEL-OIL:	1,012,300. Gal.
BENEFIT/COST RATIO:	8.2		

DD FORM 1391, 1 OCT 73

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Page No. 1

Refuse Derived Fuel - 5900 C.E.P. Project No. B408-T498

1. GENERAL. This project is needed to conserve fuel in an existing, permanent facility. Refuse collected amounts to 45 to 50 tons per day; and approximately 80% is combustible and heat can be reclaimed through incineration type boiler. This method can substantially reduce the energy now consumed with fuel-oil type boilers in an existing Central Plant.

2. ACCOMMODATIONS NOW IN USE.

Permanent Central Energy Plant #5900, 5750 S.F.

3. ANALYSIS OF DEFICIENCY. The existing Central Energy Plant is designed and used for fuel-oil fired boilers. New refuse derived fuel boiler will require addition to structure for refuse storage and handling.

4. CONSIDERATION OF ALTERNATE FACILITIES.

Not applicable.

5. CRITERIA FOR PROPOSED CONSTRUCTION. Scope of this project is to add to existing Building #5900 plant in similar construction, but with accommodation for one incinerator type boiler and accessories. This project to be coordinated with proposed coal-fired boiler plant addition #B408-T493.

6. PROGRAM FOR RELATED FURNISHINGS AND EQUIPMENT. Equipment intended for installation is to be procured with a portion of the total funds requested.

7. DISPOSAL OF PRESENT ASSETS. There will be no disposal of present assets as a result of this project.

8. SURVIVAL MEASURES.

Not applicable.

9. SUMMARY OF ENVIRONMENTAL CONSEQUENSES. This project has been reviewed and will not contribute significantly to air and water pollution.

10. EVALUATION OF FLOOD HAZARD. This project is an addition to an existing facility and is not in an area known to be subject to flooding.

11. ECONOMIC SAVINGS. An economic analysis is attached herewith.

12. UTILITIES SUPPORT. Adequate utilities support is available for this project. Connections to existing utilities will be required.

13. PROTECTION OF CULTURAL ENVIRONMENT. This project has no impact on any designated historical place.

14. PROJECT DEVELOPMENT BROCHURE. A Project Development Brochure has been prepared for this project.

15. ENERGY REQUIREMENTS.

a. Project Description. A 7110 S.F. addition to Bldg. #5900 Central Energy Plant, for housing one incinerator type boiler.

b. Estimated Energy Uses.

(1). The Central Plant addition will be heated by H.W. unit heaters connected to existing systems.

(2). No air conditioning required by this project.

(3). No hot water services required by this project.

(4). Electric power will be required for lighting and power equipment.

(5). Sewerage Systems. Sewerage connections to existing facility will be required for building addition.

c. Energy Sources.

(1). Refuse is collected daily and will be delivered to this proposed facility in lieu of being hauled an extra three miles to a land-fill.

(2). Electric Power is from existing C.E.P. Present system is adequate for requirements for this project.

(3). Water Supply is provided by the City of Lawton to existing facility. Present capacity is adequate for this proposed project.

(4). Sewerage System is Government owned and is adequate to accommodate this proposed facility.

d. Energy Use Impacts. Significant favorable impacts will result from burning refuse collected from Fort Sill. Land-fill requirements will be reduced over 70% and slight decrease in hauling expense will be realized.

e. Energy Reduction. A reduction in source energy will occur with this project. Present fuel-oil fired boilers would be displaced, thus saving energy and prolonging the life of present equipment.

f. Energy Alternatives. This is a modification project to existing systems, therefore, energy alternatives are not applicable.

g. Energy Efforts. The energy system to be utilized in this system will have a favorable impact on the present environment.

h. Basis of Appraisal. The basis for utilizing refuse for incineration in boilers is a practical approach for disposing of such wastes and at the same time decrease the necessity for relying on fossil fuel.

16. PROVISIONS FOR THE HANDICAPPED. In accordance with P.L. 90-480, no provisions for the handicapped will be made in the project since the facility will be used and operated soley by able bodied personnel.

Jack L. Van Pool
JACK L. VAN POOL
Colonel, FA
Deputy Installation Commander

BUDGETARY ESTIMATED DATA

Anticipated Construction Start Date: Apr 1982
Anticipated Construction Completion Date: Apr 1983
Anticipated Midpoint of Construction Date: Oct 1982
Construction Cost Index for Anticipated Midpoint of Cosntruction Date: 2158

Fort Sill, Oklahoma FY 1982 19 Nov 1979
Project No. B408-T498
Description: Refuse Derived Fuel - 5900 C.E.P. (ECIP)

	Quantity	Unit	Unit Cost	Total ($000)
1. Primary Facility				
a. Addition to 5900 C.E.P. Bldg. ($46/SF x 2158 ÷ 1719 = 57.75)	7110.	SF	57.75	411.
b. Solid Waste Boiler & Accessories	1	Ea.	LS	663.
c. HTHW Pump	1	Ea.	LS	3.
2. Supporting Facility				
a. Refuse and Ash Handling Equipment: (Conveyors, Hoppers, Front-end Loaders)			LS	153.
b. Electrical Power & Lighting			LS	9.
c. Piping & Insulation (Incl. Water, Sewerage)			LS	26.
Fuel Oil Piping			LS	2.
d. Site Work			LS	14.
Paving			LS	23.
e. Controls			LS	2.
Meters & Instruments			LS	7.
f. Pollution Control Equipment & Misc.			LS	88.
TOTAL ESTIMATED COST				1,401.

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ECONOMIC ANALYSIS (ECIP)

Location: Fort Sill, Oklahoma FY 1982

Project: Refuse Derived Fuel - 5900 C.E.P.

Project No. B408-T498

Economic Life 25 Yrs. Date Prepared 19 Nov 1979 Prepared By C.Robert Scruggs

COSTS

1. Non-recurring Initial Capital Costs.

a. CWE	$ 1,401,400.	
b. Design	$ 75,547.	
c. Salvage	$ -	
d. Total		$ 1,476,947.

BENEFITS

2. Recurring Benefit/Cost Differential Other Than Energy

a. Annual Labor Decrease (+)/ Increase (-)	$ 139,719. /Yr. (-)	
b. Annual Material Decrease (+)/ Increase (-)	$ - /Yr.	
c. Other Annual Decrease (+) /Increase (-)	$ - /Yr.	
d. Total Costs	$ 139,719. /Yr. (-)	
e. 10% Discount Factor	9.524	
f. Discounted Recurring Cost (d x e)		$ 1,330,684. (-)

3. Recurring Energy Benefit/Costs

a. Type of Fuel Electricity

(1) Annual Energy Decrease (+)/ Increase (-)	853. MBTU (-)
(2) Cost per MBTU	$ 2.07 /MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	$ 1,766. /Yr. (-)
(4) Differential Escalation Rate (7 %) Factor	18.049
(5) Discounted Dollar Decrease/Increase ((3)x(4))	$ 31,875. (-)

b. Type of Fuel Electric Demand

(1) Annual Energy Decrease (+)/ Increase (-)	N/A MBTU
(2) Cost per MBTU	$ - /MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	$ - /Yr.
(4) Differential Escalation Rate (7 %) Factor	-
(5) Discounted Dollar Decrease/Increase ((3)x(4))	$ -

c. Type of Fuel Fuel Oil

(1) Annual Energy Decrease (+)/ Increase (-)	140,400. MBTU (+)
(2) Cost per MBTU	$ 4.78 MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	$ 671,112. /Yr. (+)
(4) Differential Escalation Rate (8 %) Factor	20.050
(5) Discounted Dollar Decrease/Increase ((3)x(4))	$ 13,455,796. (+)

d. Type of Fuel

(1) Annual Energy Decrease (+)/ Increase (-)	- MBTU
(2) Cost per MBTU	$ - MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	$ - /Yr.
(4) Differential Escalation Rate (%)	-
(5) Discounted Dollar Decrease/Increase ((3x(4))	$ -

e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)	$13,423,921.
4. Total Benefits (Sum 2.f + 3e)	$12,093,237.
5. Discounted Benefit/Cost Ratio (Line 4 ÷ Line 1d)	8.2
6. Total Annual Energy Savings 3a(1)+3b(1)+3c(1)+3d(1)	139,547. MBTU
7. E/C Ratio (Line 6 ÷ (Line 1a/1,000))	99.6
8. Annual $ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3)	$ 529,627.
9. Payback Period ((Line 1a - Salvage) ÷ Line 8	2.7 YEARS

ECONOMIC ANALYSIS (CONT.)

1. Non-recurring Initial Capital Costs:

Construction		$ 1,042,384.
SIOH @ 5 %		$ 52,119.
Unescalated CWE		$ 1,094,503.
CWE (Escalated to End FY 82):		
$ 1094503 x 1.07 x 1.065 x 1.06 x 1.06 (Entered on Line 1.a.)	=	$ 1,401,400.
Unescalated Design @ 6 % of Construction:		
.06 x $ 1,042,384.	=	$ 62,543.
Design (Escalated to End FY 81):		
$62,543. x 1.07 x 1.065 x 1.06 x – (Entered on Line 1.b.)	=	$ 75,547.
Salvaged value of removed equipment:	=	$ –
Salvage value (Escalated to End FY 82):		
$ x 1.064 x 1.062 x 1.056 x 1.056 (Entered on Line 1.c.)	=	$ –

2. Recurring Benefit (+)/Cost (–) Differential Other Than Energy:

Labor (Unescalated)		
Labor (Escalated to End FY 82)	=	$ 110,882. (–)
$ 110882 x 1.064 x 1.062 x 1.056 x 1.056 (Entered on Line 2.a.)	=	$ 139,719. (–)
Materials (Unescalated)		
Materials (Escalated to End FY 82):	=	$ – ( )
$ – x 1.064 x 1.062 x 1.056 x 1.056 (Entered on Line 2.b.)	=	$ – ( )

3. Recurring Energy Benefits (+)/Costs (–):

a. Electric Energy: ((–)98024KWH x 8700 BTU/KWH)

MBTU Saved (Entered on Line 3.a.(1).)	=	(–) 853. MBTU
$ Cost/MBTU	=	$ 1.207 /MBTU
$ Cost/MBTU (Escalated to End FY 82):		
$ 1.207 x 1.16 x 1.16 x 1.13 x 1.13 (Entered on Line 3.a.(2).)	=	$ 2.07 /MBTU

b. Demand Charge Reduction:

MBTU Saved:		Negligible
Annual Dollar Saving	=	$ – /Yr.
Annual Dollar Saving (Escalated to End FY 82):		
$ – x 1.16 x 1.16 x 1.13 x 1.13 (Entered on Line 3.b.(3).)	=	$ –

c. Distillate Fuel Oil: (1012300 Gallons x 138,700 BTU/GAL.)

MBTU Saved (Entered on Line 3.c.(1).)	=	140,400. MBTU
$ Cost/MBTU	=	$ 2.732 /MBTU
$ Cost/MBTU (Escalated to End FY 82):		
$ 2.732 x 1.16 x 1.16 x 1.14 x 1.14 (Entered on Line 3.c.(2).)	=	$ 4.78 /MBTU

LEGEND

ABBREVIATIONS	DENOTATION
K	KILO (10^3)
$\bar{M}$	MEGA (10^6)
KBH	1000 BTU/HR.
$\bar{M}$BH	MEGA BTU/HR.
$\bar{M}$BTU/YR. (or $\bar{M}$BU/YR)	MEGA BTU/YEAR
CF	CUBIC FEET
GAL	GALLON
KWH	KILO WATT HOURS

FUEL	COST OF FUEL @ FT. SILL	COST OF FUEL @ SOURCE	REMARKS
NATURAL GAS (JAN '78)	$1.305/KCF	$1.231/$\bar{M}$BU	RE: ARKLA GAS COMPANY @ 1060 BTU/CF.
FUEL OIL #2 (JUL '78)	$0.3789/GAL	$2.732/$\bar{M}$BU	RE: KERR-McGEE COMPANY *1 DISTIL. F.O. @ 138,700 BTU/GAL.
COAL (APR '78)	$40.75/TON	$1.658/$\bar{M}$BU	RE: ASSOCIATED PRODUCERS COMPANY @ 13,478 BTU/LB OR 26.956 $\bar{M}$BU/TON *1 USE: 24.58 $\bar{M}$BU/TON
ELECTRICITY (SEPT '78)			RE: PUBLIC SERVICE CO. OF OKLA. & SWPA
ENERGY CHARGES			25% HYDRO-ELEC. @ $0.002/KWH TO 4.877 $\bar{M}$KWH + $0.003/KWH ALL OVER 4.877 $\bar{M}$KWH 75% FOSSIL FUEL @ $0.01338/KWH: 25% @ $0.002 = $0.0005 75% @ $0.01338 = $0.0100
	$0.0105/KWH		$0.0105/KWH
		$1.207/$\bar{M}$BU	$0.0105/KWH (75% x 11,600 BTU/KWH *2) + (25% x 0 BTU/KWH (HYDRO-ELEC.) = $0.0105 x 8700 = $1.207/$\bar{M}$BU (@ SOURCE)
	$3.076/$\bar{M}$BU		FROM 8700 BTU/KWH TO 3414 BTU/KWH (@ FT.SILL): 2.548 x $1.207 = $3.076/$\bar{M}$BU (@ FT. SILL)
DEMAND CHARGES	$1.60/KW		RE: PUBLIC SERVICE CO. OF OKLA. MINIMUM MONTHLY CHARGE BASED ON 32,500 KW x $1.60 = $52,000

*1 RE: ECIP

*2 For this report, we have taken the recommended 11,600 BTU/KWH as given by the ECIP Guidance (DAEN-FEU, 7 Nov. 1977) for Source Energy and derated it 25% or 8700 BTU/KWH because of the advantages Ft. Sill is receiving from hydroelectric generation.

carnahan-thompson-delano, inc. professional consulting engineers PROJECT NO. 1367 RDF-5900 CEP FEDERAL CONTRACT NO DACA63-77-C-0105	SUBJECT FUEL CHARGES-ENERGY COST-LEGEND PREPARATION OF ENERGY CONTROL SYSTEM FOR FT. SILL, OK BY CRS-JHG-PRMc DATE 23 Feb '79 CHK C.R.S. DATE 29 June '79 REV	1 OF 6

ECONOMIC ANALYSIS BACK-UP

FY PROGRAM	INSTALLED BOILER CAPACITIES	CAPACITIES LOAD $\bar{M}$BH	TOTAL CONNECTED $\bar{M}$BH
'79 (Existing)	2 @ 9.8 $\bar{M}$BH	19.464	19.464
'80	Add 2-15. $\bar{M}$BH *1	22.369	41.833
'81	Add 2-15. $\bar{M}$BH *1	16.434	58.267
'82	-	-0-	58.267

Add 1 new RDF Boiler w/Fuel-oil standby.

Capacity of Boiler based upon following:

1. Total Refuse Collected = 45 to 50 Tons/Day
2. Collecting & Hauling Costs (1 May '77 thru 30 Apr '78) = $375,452.

Basis of Study: *2

1. Weight of Refuse = 600 #/yd^3
2. Class I Rubbish Consisting of:
   a. Combustible Waste: = 80%
      Paper, rags, woodscraps, combustible floor sweepings, domestic, commercial & industrial sources
   b. Garbage = 20%
      (Moisture Content of Garbage = 25%)
      (Non-Combustible Solids of Above = 10%)
3. BTU Value of Refuse as Fired. = 6,500 BTU/#
   BTU of Auxiliary Fuel Not in Calculations
4. Total #/Day = 45 Tons X 80% (Combust. Refuse) X 2,000 #/Ton = 72,000 #/Day

   Total BTU/Day = 72,000 #/Day X 6,500 BTU/# = 468 $\bar{M}$BTU/Day

   Hourly Value = $\frac{468\ \bar{M}BTU/Day}{24\ Hrs/Day}$ = 19.50 $\bar{M}$BH

   $\frac{19.50\ \bar{M}BH}{6,500\ BTU/\#}$ *3 = 3,000#

   Try: Basic Solid Waste Boiler Model #3000-B @ 24 $\bar{M}$BTU/Hr input @ 70% Efficiency = 16.8 $\bar{M}$BH

5. Total Energy Estimated Per Year From RDF:

   E = 468 $\bar{M}$BTU/Day X 300 (Pick-up) Days/Year = 140,400. $\bar{M}$BTU/Yr (Total Input RDF)

   1-Fuel-oil Fired Boiler (Exist'g FY'80) = 15 MBH

   $\frac{15.\ \bar{M}}{.70(eff.)}$ X 24 Hrs X 300 Days/Yr = 154,286 $\bar{M}$BTU/Yr (Total Input F.O.)

*3 Re: International Boiler Works Co. & Basic Environmental Engineer'g Co.
*2 Re: Basic Environmental Engineer'g Co.
*1 Re: Wilson & Co. Study of 6000 Area Programming.

"A" Assume Energy from 1 Fuel-oil Boiler Saved with 1-#3000-B RDF Boiler or — 140,400 MBTU/Yr (Min. Saved)

"B" Annual Costs/Benefits:

		$ Per Year Saved (+)	$ Per Year Cost (-)
1. Refuse Contract Reduction:			
100% Refuse collected & hauled to RDF site in lieu of Dump	= 45 Tons		
20% Non-Combustibles	= 9 Tons		
80% Combustibles = 36 Tons			
10% Ashes	= 3.6 Tons		
To Sanitation-Fill	= 12.6 Tons		
Assume contract reduction to be based on following:			
a. 6 mile round-trip to dump site (in lieu of 13 miles) say 50% reduction.			
b. Sanitation fill charges reduced $\left(\frac{12.6 \text{ Tons}}{45 \text{ Tons}}\right)$ to 28%			
Estimate Sanitation Contract Reduction @ 15% X $375,452	=	$56,318.	
2. Additional operators & laborers to handle RDF equipment, separation & maintenance on 24 hr. basis:			
2 men X 24 hrs X 365 days/yr X $10/hr	=		$175,200.
3. Assume vehicle costs & energy usage for RDF handling to be offset with truck hauling to dump site.		-0-	-0-
4. Extended life of 1 Fuel-oil boiler and accessories not in use during RDF firing:			
1 Boiler, pump & accy's = $200,000/25 yrs	=	8,000.	
TOTALS	=	$64,318.	$175,200.
Net recurring costs			$110,882.(-)

"C" Energy expended w/RDF plant as compared to Fuel-oil boiler.

Forced Draft Blower motor	10 Hp
After-Burner Blower motor	5 Hp
Misc. Motors: Powered plug ash remover, plug spreader feeder, bomb bay doors, ash conveyor, non-combustible conveyors, induced draft blower, etc.	10 Hp ± (w/diversity)
TOTAL	25 Hp ±
LESS: Conventional Fuel-oil Boiler Blower Motor	(-) 10 Hp
NET ESTIMATED ADDITIONAL	15 Hp ±

Assume:

$E_{(Elec'l)} = 15 \text{ Hp} \times 0.746 \text{ Kw/Hp} \times 24 \text{ Hrs/Day} \times 365 \text{ Days/Yr}$

$E_{(Elec'l)} = $ 98,024 Kwh/Yr additional

carnahan-thompson-delano, inc. professional consulting engineers PROJECT NO. RDF-5900 CEP	SUBJECT Economic Analysis Back-up PREPARATION OF ENERGY CONTROL SYSTEM FOR FT. SILL, OK. BY CRS DATE 19 Nov 79	3 OF 6

$\sum$ COSTS/SAVINGS PER YEAR

METHOD	TOTAL SOURCE MBTU	TOTAL FUEL SAVED ELECTRIC KWH	TOTAL FUEL SAVED #2 OIL MBTU	RECURRING COSTS	DESCRIPTION OF COSTS/ SAVINGS METHOD
"A"	140,400.	-	140,400.	-	Fuel oil saved
"B"	-	-	-	(-) $110,882.	Recurring costs
"C"	(-) 853.	(-) 98,024.	-	-	Electric Energy expended
TOTALS	139,547	(-) 98,024. ((-) 853. MBTU/Yr)	140,400. (1,012,300. Gal)	(-) $110,882.	